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Critical intelligence and its development.

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CRITICAL INTELLIGENCE AND ITS DEVELOPMENT

A Dissertation Presented

By

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A B S T R A C T

Critical Intelligence and Its Development

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How can critical intelligence or critical thinking be taught? A clear, detailed answer to this question is important to professional educators. Philosophers, for example, have some interest in teaching critical thinking and in encouraging its exercise by students of philosophy. This exercise involves the critical evaluation of philosophical arguments. However, the educational importance of critical intelligence goes well beyond the critical evaluation of philosophical arguments. Educators in the social sciences, the natural sciences, the humanities, as well as in professional schools attempt to encourage the development of critical intelligence. For example, students are asked critically to evaluate theories, to support certain conclusions with relevant evidence, and to organize and to write critical essays and term papers. Nor is developing critical intelligence simply confined to classroom activities. Educators often hope that their students

will evaluate sales pitches, political arguments, and proposed explanations through critical deliberation, not simply in an arbitrary, emotional manner.

Given these and other motives, educators, educational psychologists, and philosophers of education have offered numerous answers to this question. To answer this question, they attempt to provide what they consider to be successful teaching methods or to develop what they consider to be successful curricula for this purpose. However, such attempted answers do not answer three obvious prior questions. To answer this question, one must first answer a prior question "Can critical intelligence be taught?" To answer this question, one must first answer two other prior philosophical questions: "What is critical intelligence?" and "What is teaching?" The failure to address these prior questions is one reason why these attempted answers are neither sufficiently clear, nor sufficiently detailed. The original question, therefore, is really the fourth of four questions:

1. What is critical intelligence or critical thinking?
2. What is teaching?
3. Can critical intelligence or critical thinking be taught?

4. How can critical intelligence or critical thinking be taught?

Some educators, educational psychologists and philosophers of education have attempted to answer question 1 and others have attempted to answer question 2. To answer these questions, most have attempted to provide definitions of the terms: definitions of 'critical intelligence' and definitions of 'teaching'. Yet there is an urgent difficulty involving such definitions and the attempt to answer questions 3 and 4. In debates among sponsors of alternative answers to questions 3 and 4, we must not assume that the terms 'critical intelligence' or 'teaching' are used univocally. Thus, it is not always clear that educators, educational psychologists or philosophers of education are attempting to answer the same question. To evaluate these answers, we must clarify and evaluate the definitions they offer for these terms.

Those writing in the field of education often write as if there were no philosophical problems or issues involved in providing such definitions. While offering a solution to the philosophical problems of definition is beyond the scope of this dissertation, I do clarify and evaluate proposed definitions of 'critical thinking' in order to reach a clear and defensible understanding of the concept of critical intelligence and thereby answer question 1 in Chapter I. I then clarify and evaluate proposed definitions of 'teaching' in order to reach a clear and defensible understanding of this concept and thereby answer question 2 in Chapter II. Given a clear understanding of these concepts, I then answer question 3 in Chapter III, and finally answer the original question, question 4, in Chapter IV. In the Appendix, I present an instructional model for the development of critical intelligence.

CONTENTS

INTRODUCTION

"Begin at the beginning", the King said very gravely, "and go on till you come to the end: then stop."
Lewis Carroll, from
Alice in Wonderland

In this dissertation, I provide a clarification of two concepts, critical intelligence in terms of critical thinking, and teaching, in order to answer two questions in the philosophy of education: "Can critical intelligence be taught?", and if so, "How can critical intelligence be taught?" The clarification of these two concepts involves appealing to concepts that raise important questions in metaphysics, epistemology, philosophy of science, logic, and philosophy of action. For example, critical thinking seems to involve part of reasoning, some mental activity, some dispositions and both deductive and inductive logic. Teaching seems to involve some intentional action, the concepts of knowledge and belief, and specifically knowledge or beliefs about other minds. In this dissertation, however, I do not, in turn, provide an answer to the important questions raised by central concepts in metaphysics, epistemology, philosophy of science, logic, or philosophy of action. Answering such important questions may involve many dissertations.

The main focus of this dissertation is a clarification of these two concepts sufficient to answer these two questions in in the philosophy of education. Indeed both critical thinking (as part of reasoning) and teaching are two central concepts in education, so their clarification is an important task for philosophers of education. Furthermore, the two questions "Can critical intelligence be taught?," and if so, "How can critical intelligence be taught?" are two central questions in the philosophy of education. They bear a close relation to the question of teaching virtue raised by Plato in the _Meno_. While many educators worry about how to teach critical thinking, or how to develop critical intelligence, no philosopher of education had considered these two questions with sufficient clarity to provide a definitive answer. This is the task of my dissertation.

In Chapter I, I clarify 'critical thinking' and 'critical intelligence' by providing a definition of what it is to be engaged in critical thinking, D.10, a definition of what it is to be engaged in correct critical thinking, D.11, and a definition of what it is to be critically intelligent to a particular degree, D.12. In Chapter II, I clarify 'teaching' by distinguishing teaching how and teaching that, and by providing definitions of what it is to be engaged in teaching that, D.20, what it is to be engaged in teaching how, D.21, and what it is to be engaged in teaching, D.22. With these two concepts clarified, we are in a clearer position to answer these two questions.

In Chapter III, I answer the question "Can critical intelligence be taught?" affirmatively, and provide necessary and sufficient conditions for successfully teaching critical intelligence. I argue that determining the success of the teaching is a contingent matter that, in turn, involves arguing that the conditions of D.11 are, as a matter of empirical fact, met. In Chapter IV, I answer the question "How can critical intelligence be taught?" by providing a curriculum such that successfully teaching it is sufficient successfully to teach correct critical thinking. I then consider the question of method, and argue that any method for successfully teaching correct critical thinking must be such that the second disjunct of D.20 is satisfied, and the second disjunct of D.21 is satisfied. I then show that the choice of a method is based on at least five contingent factors.

In the Appendix, I present an instructional model which serves to show how critical intelligence can be taught successfully. I clearly present a curriculum the successful teaching of which is sufficient successfully to teach correct critical thinking. It is an example of the application of D.12, D.22, and my answers to these two questions in the philosophy of education to a particular curriculum. This example of the application of D.12, D.22 and my answers to these two questions has both a theoretical and a practical importance.

There are at least three features of this model that are theoretically important. First, the model specifically shows the kind of activity that must be taught successfully to teach correct critical thinking and to develop critical intelligence. The depth of treatment has been shown to vary given different curricula and different educational contexts. Secondly, the model shows that correct critical thinking is not "applying philosophy to other fields." Critical thinking, as part of reasoning, is central to many disciplines and professions, as well as to the everyday concerns of rational persons. Critical thinking is not by any means the exclusive concern of philosophy. Thirdly, the model shows what might pre-analytically be called a specific interdisciplinary activity. It, therefore, may help philosophers of education begin to work out a clear concept of an interdisciplinary activity.

There are at least five features of this model that are practically important. First, the model serves as a manual for instructors such that the instructor, for practical purposes, needs no special background or training to follow it, or to teach from it. Secondly, the model shows how, in fact, successfully to teach critical intelligence to a particular degree in a college level curriculum. Thirdly, the model serves as a blueprint for a college level program in critical thinking. Fourthly, the model shows that perhaps some philosophers are, in fact, better prepared to teach critical thinking than those in other disciplines, although there is no necessity that this be so. Fifthly, the model provides practical insight into the teaching of clear, tightly organized writing, provided we grant that clear writing proceeds from clearer thinking.

CHAPTER I

WHAT IS CRITICAL INTELLIGENCE AND WHAT IS CRITICAL THINKING?

Those who claim to have an objective, scientific test to measure the ability to engage in critical thinking often construe the test as providing an operational definition of 'critical intelligence' in terms of specific critical thinking abilities. The Watson-Glaser Critical Thinking Appraisal is perhaps the most well known and widely used test of critical thinking. As such, it is easily construable as providing an operational definition of 'critical intelligence' in terms of specific critical thinking abilities. In the attempt to provide a definition of 'critical intelligence', I shall examine and evaluate the attempt to define 'critical intelligence' in terms of the Watson-Glaser critical thinking appraisal.

The Watson-Glaser Critical Thinking Appraisal is a test consisting of five subtests.[1] The subtests are entitled by the general critical thinking ability they are designed

[1] G. B. Watson and E. M. Glaser, Watson-Glaser Critical Thinking Appraisal (New York: Harcourt, Brace and World, 1964), p. 2. Other tests of critical thinking, subject to the same basic construal, are the Ace Test of Critical Thinking and the Principles of Critical Thinking Test, prepared by the Illinois Curriculum Project.

to measure. The subtest, the number of questions in each subtest, and the specific behaviors in terms of specific critical thinking abilities in the test may be summarized as follows:

	Column A Sub Test	Column B Questions	Column C Specific Ability
1.	Inference	20	"Samples ability to discriminate among degrees of truth or falsity of inferences drawn from given data."
2.	Recognition of Assumptions	16	"Samples ability to recognize unstated assumptions."
3.	Deduction	25	"Samples ability to reason deductively from given statements, to recognize the relation of implication between propositions to determine if what appears to be an implication or a necessary inference from given premises is such."
4.	Interpretation	24	"Samples ability to weigh evidence, to distinguish between a) generalizations from data not warranted beyond reasonable doubt, and b) generalizations not necessary but warranted beyond reasonable doubt."
5.	Evaluation of Arguments	15	"Samples ability to distinguish between strong arguments relevant to a particular question at issue."

A definition of 'critical intelligence' in terms of the specific critical thinking abilities listed in Column C and the general critical thinking abilities listed in Column A can be specified in terms of some numerical test score N. Given these five sub tests, said to test the specific abilities listed in Column C, someone scoring correctly on N out of 100 questions (Column B) is said to have the ability to engage in critical thinking.[2] We might, therefore, consider a definition of 'critical thinking' as follows:

D. x is critically intelligent iff x scores N on the Watson-Glaser Critical Thinking Appraisal.

However, D as it stands will not do as a definition of 'critical intelligence'. We can think of cases in which x has critical intelligence yet x does not score N on the Watson-Glaser test. For example, x might have taken the test while sick with the flu, or stricken with grief, or in a mischievous mood; or x might be critically intelligent yet never take the test and, therefore, never score at all; or x might be a critically intelligent native Frenchman who reads and speaks no English, and, therefore, cannot understand the test. Therefore, D, as it stands, does not

[2] I shall ignore the complex scoring of the test. If the test does measure critical thinking ability, then if someone scores N out of 100, I shall grant that that someone is said to be able to engage in critical thinking according to the test results and that, therefore, the score N is sufficient to measure critical intelligence. This is sufficient for my purposes.

successfully provide both necessary and sufficient conditions for critical intelligence.

We may consider modifying D to remedy this defect:

D.1 x is critically intelligent iff if x takes the Watson-Glaser Critical Thinking Appraisal in x's native language and x is healthy, unemotional and serious, then x scores N on the test.

However, D.1 also will not do as a definition of 'critical intelligence'. The problem not only concerns specific problems with the Watson-Glaser test of critical thinking, but also concerns a more basic problem with any such tests construed as definitions. Given the five sub tests (Column A) and the specific abilities (Column C) thought to be both jointly necessary and singly sufficient for critical thinking, there are cases in which x scores N on the test and x is not critically intelligent. In terms of D.1, this is to argue that there is an instance of x such that if x takes the Watson-Glaser test in x's native language, and x is healthy, unemotional and serious, then x scores N on the test and x is not critically intelligent. There are also cases in which x is critically intelligent and x does not score N on the test. In terms of D.1, this is to argue that there is an instance of X such that x is critically intelligent and if x takes the Watson-Glaser test in x's native language, and x is healthy, unemotional and serious, then x does not score N on the test.[3]

[3] Many arguments of this sort are offered in the literature about this test. See Robert Ennis, "An Appraisal of the Watson-Glaser Critical Thinking Appraisal," Journal of Education Research, No. 52 (Dec. 1958), pp. 155-158.

Consider as an example sub test 1. In this sub test, the testee is asked to read a paragraph from which a specific conclusion is drawn. The instructions for this section direct the testee to evaluate this conclusion by choosing among the following responses: "a. True; b. Probably True; c. Insufficient Data; d. Probably False; e. False."

One such paragraph reads, in part: "Students from high income groups took part in many more of the extracurricular school activities which cost money than did students from low income homes." The conclusion drawn from this paragraph is: "Many students from low income homes felt they couldn't afford to participate in extracurricular activities which cost money." The answer key indicates that the correct answer is "b. Probably True."

Clearly, the conclusion does not follow deductively from the paragraph (taken to be composed of true statements). Yet is the conclusion probably true, given the paragraph? Suppose the testee exercises critical thinking when facing this question. The testee considers the possibility that the income factor does not explain participation or lack of participation in extracurricular school activities which cost money. Suppose that high income students also took part in many more of the free extracurricular activities than did students from low income homes, a possibility given the paragraph. Then the correct answer concerning the conclusion seems to be "c. Insufficient Data," since there is not enough information about the relation of income to participation.

Therefore, one taking the test may engage in critical thinking and be marked wrong on the test. Therefore, one may actually be critically intelligent and while taking the test in one's native language, in good health, unemotionally and seriously, may not score N on the test.

Given the answer key to the test, it is also possible that one may take the test under the appropriate conditions, score N, and not be critically intelligent. If one is a

But aside from these specific problems with the Watson-Glaser test, there is a more basic problem with construing any such test as a definition, even granting that the test successfully measures critical intelligence. Even if a test correctly measures some ability according to other abilities, the test cannot intelligibly be construed as offering a definition of the ability measured. Consider the following example. Suppose we construct a test composed of performing different (x, y, z) movements on a machine to measure the abilities thought to be jointly necessary and singly sufficient to have the ability to swim. Yet it is not necessary that 'movements x, y, z on a machine' have the same meaning as 'swimming'. The test, therefore, does not define 'swimming' because it does not give the meaning of the term, even though we may assume that the test correctly measures the ability to swim.

This charge equally applies to tests of critical thinking like the Watson-Glaser Critical Thinking Appraisal. Even granting for the sake of argument that the test correctly measures the ability to engage in critical thinking according to the abilities of Column C, and thereby granting

pathological doubter, and consistently answers "d." or "e.", because of the answer key he will score very highly on the test. Therefore, there are instances of x such that x takes the test under the appropriate conditions, scores N, yet is not critically intelligent.

that the test correctly measures critical intelligence, the test cannot intelligibly be construed as offering a definition of 'critical intelligence'. It is not necessary that 'score N on the Watson-Glaser test' has the same meaning as 'critical intelligence' even though we may assume that the test correctly measures critical intelligence. We must, therefore, reject this kind of definition and seek another kind of definition for 'critical intelligence'.

We can easily offer another kind of definition for 'critical intelligence':

D.2 x is critically intelligent iff x has the ability to engage in critical thinking.

However, there are several problems with D.2 as it stands. Like other kinds of intelligence, it seems to make sense that different people may possess different degrees of critical intelligence. We might also expect different people to engage in critical thinking with different degrees of proficiency. But D.2 attempts to define 'critical intelligence' by giving both necessary and sufficient conditions for its presence. It is, therefore, not concerned to discriminate among different degrees of critical intelligence, but simply to identify its presence.

However, D.2 faces another serious problem. It attempts to define an unclear term, 'critical intelligence', in terms of an equally unclear term, 'critical thinking'. Therefore, as a definition attempting to provide both a necessary and a sufficient condition for 'critical intelligence', D.2 is of little help as it stands. We must also seek a clear definition of 'critical thinking' in order clearly to understand D.2. Such a definition of 'critical thinking', to be acceptable, must provide both necessary and sufficient conditions for 'critical thinking'.

Educators, educational psychologists and philosophers of education have provided numerous descriptions of critical thinking. D. H. Russell notes that one of his doctoral candidates discovered thirty-five descriptions of critical thinking from various educational journals.[4] However, from these many descriptions of critical thinking, two basic groups emerge. The first group of definitions are attempts to define 'critical thinking' in terms of some other general notion or notions. The second group of definitions are attempts to define 'critical thinking' in terms of specific behaviors, in turn specifiable in terms of specific abilities. In each group, many of the suggested definitions

[4] D. H. Russell, "The Prerequisite: Knowing How to Read Critically," Elementary English, No. 40 (Oct. 1963), pp. 579-580.

are very similar. Rather than consider every definition offered, I shall consider a representative sample from each group in an attempt to formulate a satisfactory definition of 'critical thinking'.[5]

[5] Other authors offering definitions similar to one or more of the definitions I consider in group one are:

P. Dressel, "Critical Thinking," Education Digest, No. 21 (Dec. 1955), pp. 16-17.

P. F. Kavett, "An Activity Approach to Critical Thinking," The Instructor, No. 73 (Nov. 1963), p. 116.

F. H. Ferrell, "Critical Thinking," The Education Digest, No. 14 (Jan. 1949) pp. 14-16.

C. C. Kemp, "Improvement of Critical Thinking in Relation to Open-Closed Belief Systems," Journal of Experimental Education, No. 31 (March 1963) pp. 321-323.

H. A. Anderson, "Critical Thinking Through Instruction in English," The English Journal, No. 36 (Feb. 1947) pp. 75-76.

Other authors offering definitions similar to one or more of the definitions I consider in group two are:

D. H. Russell, "Higher Mental Processes," ed. C. W. Harris, Encyclopedia of Educational Research (New York: The MacMillan Co., 1960), p. 651.

D. H. Russell, "Critical Thinking in Childhood and Youth," The School, No. 31 (May 1943), p. 76.

D. H. Russell, "Education for Critical Thinking," The School, No. 30 (Nov. 1941), p. 188.

R. Karlin, "Critical Reading is Critical Thinking," Education, No. 84 (Sept. 1963) pp. 8-11.

R. Ellsworth, "Critical Thinking," The National Elementary Principal, No. 42 (May 1963) pp. 24-29.

H. D. Herber, An Inquiry Into the Effect of Instruction in Critical Thinking Upon Students in Grades 10, 11, and 12, (Unpublished Doctoral Dissertation, Boston University, 1959).

Definitions of 'Critical Thinking': Group One

H. A. Pulling describes critical thinking in terms of "the stimulation of original thought."[6] Pulling argues that teachers and librarians need to encourage the stimulation of original thought in order to encourage critical thinking. He then supplies a brief account of how this might be done. The educational purpose of stimulating original thought, according to Pulling, is "to develop a sense of wonder in children which will lead them to make informed guesses and to develop hypotheses." He also argues that teachers and librarians need to encourage the development of this sense of wonder in children in order to lead them to make informed guesses and to develop hypotheses in order to encourage critical thinking.

M. Usery, "Critical Thinking Through Children's Literature," Elementary English, No. 43 (Feb. 1966), p. 116

B. D'Angelo, The Teaching of Critical Thinking (BGR, Amsterdam, 1971).

R. Ennis, "The Concept of Critical Thinking," Harvard Education Review, No. 32 (Winter 1962), pp. 81-111.

T. W. Organ, The Art of Critical Thinking (Houghton-Mifflin Co., Boston, 1965).

[6] H. A. Pulling, "Teacher and Librarian in Development of Critical Thinking," California Journal of Secondary Education, No. 34 (Dec. 1959), p. 459.

He then supplies a brief account of how this might be done. In both cases, the concern is to develop critical thinking.

We may, therefore, suppose that Pulling might consider stimulating original thought, making informed guesses, and developing hypotheses as necessary components of critical thinking, since he claims that we need to develop them in order to develop critical thinking. We might also suppose that they are sufficient, and propose the following definition of 'critical thinking' on Pulling's behalf:

D.3 x is engaged in critical thinking iff x is engaged in a process of stimulating original thought, or making informed guesses, or developing hypotheses.

Like all other definitions in group one, D.3 is hopelessly unclear. The first problem is that "stimulating original thought" is unclear, i.e., what is included in 'stimulating' and what are considered 'original thoughts'? Suppose someone drinks a quart of wine laced with LSD and then produces a rambling, confused, but original poem. According to D.3, this case of engaging in the process of drinking a quart of wine laced with LSD is a case of engaging in critical thinking, since this process stimulated original thought. Yet this is not what we mean when we say that someone is engaged in critical thought.

The second problem is that "making informed guesses" is unclear, i.e., what is an 'informed guess'? Suppose a bookie gets a tip that Silver Blaze will win in the fifth, and then bets on Silver Blaze to win in the fifth. According to D.2, this case of a bookie engaging in making an informed guess is a case of engaging in critical thinking. Yet intuitively this is not what we mean when we say that someone is engaged in critical thinking.

The third problem is that "developing hypotheses" seems to involve what we may preanalytically call creative thinking, but does not necessarily involve critical thinking. We may develop hypotheses by intuition, lucky guess, accident, native genius, or informed guess. None of these methods necessarily involve what we call 'critical thinking'. Pulling, like many others offering descriptions of critical thinking, seems to confuse critical thinking with creative thinking. Given these problems, it is clear that D.3 does not provide necessary and sufficient conditions for critical thinking. Therefore, it is not a useful definition of 'critical thinking.'

C. De Zufra, Jr. describes critical thinking in terms of "the control of emotions, the curbing of impulsiveness; it is recognition of cause and effects; it is creative; it is problem solving; . . . critical thinking is the making of choices."[7] A definition of 'critical thinking' according to De Zufra's account is:

D.4 x is engaged in critical thinking iff x is engaged in controlling emotions, or curbing impulses, or recognizing cause and effect relations, or solving problems, or making choices.

D.4 can also be shown not to provide successfully both necessary and sufficient conditions for critical thinking. Again, the major problem is that the definiens is unclear. Suppose a four year old child falls while learning to rollerskate. Suppose the child is self-conscious about crying in front of peers, so he holds back the tears. According to D.4, this child is engaged in critical thinking. However, he is not engaged in critical thinking. Therefore, controlling emotions is not a sufficient condition for engaging in critical thinking.

Suppose a member of Weight Watchers wires his jaws to control his impulse to overeat. In having this jaws wired, according to D.4, he is engaging in critical thinking. He may claim that this is a creative method of curbing the impulse to overeat, and that this involves creative

[7] C. De Zaffra, Jr., "Teaching for Critical Thinking," Clearing House, No. 31 (April 1957), p. 231.

thinking, but does not involve critical thinking. Therefore, simply curbing impulses is not a sufficient condition for engaging in critical thinking.

Suppose someone witnesses a hit-and-run accident. This someone sees a car strike a pedestrian, causing serious injury, and then speed away. According to D.4, in witnessing this accident, one is engaging in critical thinking. Yet our intuitions tell us that this does not involve critical thinking. Therefore, simply recognizing cause and effect relations is not a sufficient condition for engaging in critical thinking.

Suppose a Mafia leader has a problem. A witness' testimony will send him to prison for life. He elects to solve the problem by having the witness murdered. According to D.4, engaging in having the witness murdered is engaging in critical thinking. This, like wiring one's jaws to curb the impulse to overeat, may involve creative thinking, but it does not involve critical thinking. Therefore, simply solving problems is not a sufficient condition for engaging in critical thinking.

Suppose I choose to have strawberry topping on my ice cream. According to D.4, in choosing strawberry topping I am engaging in critical thinking. Yet our intuitions tell us that this is false. Therefore, simply making choices is not a sufficient condition for engaging in critical thinking. Therefore, D.4 does not provide both necessary and sufficient conditions for critical thinking.

However, might these conditions be jointly sufficient? We may reformulate D.4 as follows:

D.5 x is engaged in critical thinking iff x is engaged in controlling emotions, and curbing impulses and recognizing cause and effect relations, and solving problems, and making choices.

However, even granting that these may be jointly sufficient, they are clearly not necessary. Suppose a stranger says to me "I believe there are men from Mars, therefore, there are men from Mars." Suppose I point out to him that while I have no reason to doubt that he believes that there are men from Mars, it does not follow from his belief that there are men from Mars. I also point out and explain that this error in reasoning involves appealing to a false principle. Intuitively we want to be able to say that in making this reply, I am engaging in critical thinking. In making this reply, I feel no emotions to control; neither hatred nor fear, nor anger nor love. I also feel no impulses to curb; neither to hit him, nor to kick him, nor to tell him that he is stupid. There are no cause and effect relations here to recognize, and no choices to be made, unless we include as "making a choice" the decision to reply at all. Therefore, neither D.4 nor D.5 provide necessary conditions for engaging in critical thinking. At most, D.5 provides a jointly sufficient condition. Therefore, neither D.4 nor D.5 is a useful definition of 'critical thinking'; neither provides both necessary and sufficient conditions for engaging in critical thinking.

K. O. Budmen describes critical thinking in terms of "subjective judgments." He argues that teachers unfortunately confuse critical thinking with what he calls "the scientific method."[8] Unlike "the scientific method," which he claims is objective and provides conclusions based upon verifiable evidence, critical thinking is based upon "emotive premises and rooted in value constructs." These value constructs and emotions differ among individuals. He argues that while what he calls the scientific method allows us objectively and mechanically to determine that a conclusion is true, what he calls critical thinking does not allow us objectively and mechanically to determine that a conclusion is true. Budman's account seems to be based on the observation that there is universal agreement about the conclusions reached in science, but no universal agreement about the conclusions

[8] K. O. Budmen, "What Do You Think, Teacher?", <u>Peabody Journal of Education</u>, No. 45 (July 1967), p. 3.

reached in ethics, or other fields that Budmen claims rely on critical thinking rather than on the scientific method to verify conclusions. Critical thinking, therefore, according to Budmen, involves subjective and individual rather than objective and universal judgments.

Although Budmen never gives an account of what the scientific method might be or how it is objective and universal, his account of critical thinking is intended to capture the subjective, individual elements which he thinks explain the lack of agreement concerning conclusions verified by critical thinking. We may, therefore, suppose that Budmen considers engaging in making these subjective judgments, by appeal to these individual values and emotions, engaging in critical thinking.

D.6 x is engaged in critical thinking iff x is engaged in making subjective judgments by appealing to individual values and emotive feelings toward premises.

Many educators, like Budmen, mistakenly believe that critical thinking is relative only to individual values and emotions. They seem mistakenly to infer that because critical thinking is done by individuals, it, therefore, can be understood only as an individual activity which is different for different individuals, varying with individual values and emotions. But because all judgments are made by individuals, we need not suppose that no judgment made by an individual can be based on universally specifiable rules, or objective evidence. Indeed, even the objective universal judgments made according to the scientific method are made by individuals and are subjective in that very uninteresting sense.

We can make a judgment and support it by appealing to such specifiable rules or objective evidence and not appeal to individual values and emotive feelings toward premises at all. For example, one may make the judgment that "if P then Q; Q, therefore, P" is an invalid argument form without appealing to individual values and emotions (assuming we understand what these are and how such appeals work). In this case, one may appeal to the rules of valid inference, or simply take a lucky guess in making the judgment.

D.6 implies that critical thinking is concerned only with judgments based on individual values and emotions. Yet, judging the above argument form to be invalid may involve critical thinking, yet does not involve making a judgment based on individual values and emotions. Furthermore, making such judgments does not necessarily seem to involve engaging in critical thinking. Therefore, D.6 is not a good definition of 'critical thinking'.

Definitions of 'Critical Thinking': Group Two

Because general definitions like D.3, D.4, D.5 and D.6 are hopelessly unclear, they can easily be shown to fail in the attempt to provide necessary and sufficient conditions for critical thinking. Several educators have attempted to overcome these difficulties with proposed definitions of 'critical thinking' by providing definitions of 'critical thinking' in turn specifiable in terms of specific skills and specific abilities. Such a definition, if it can be shown to be successful, has two obvious advantages. First, the presence of such specific skills and specific abilities is presumed to be empirically testable, and, therefore, we may construct tests to measure critical thinking. Secondly, once we determine what teaching is, we need only examine the specific skills and abilities composing the definition and determine if they can be taught to determine whether critical thinking can be taught. With these advantages in mind, we must carefully examine such definitions and determine if one is successful.

R. E. Pingry suggests a basic guideline for such definitions of 'critical thinking' based on a desire to secure these two obvious advantages. He argues that:

> "Critical thinking has a great number of aspects and means many different things to different people. Hence, as a descriptive phrase, critical thinking is of little use by itself to describe outcomes of learning. It is necessary and important that critical thinking be defined or supplemented by specific outcomes of learning in terms of actual behavior characteristics and skills desired."[9]

Elliot W. Eisner attempts to follow this guideline and to define 'critical thinking' in terms of specific skills and abilities, evidenced by specific behavior. He argues that "Terms such as 'critical thinking' . . . can be found in almost any education journal but the specification of the particular behaviors that constitute it is another matter . . . 'critical thinking' is often so broadly conceived as to make (the term) functionally meaningless."[10] Therefore, his concern is to provide a definition of 'critical thinking' that will allow us clearly to delineate "specific behaviors that contribute to or consitute . . . critical thinking."[11]

[9] R. E. Pingry, "Critical Thinking: What Is It?," The Mathematics Teacher, No. 44 (Nov. 1951) pp. 466-470.

[10] E. W. Eisner, "Critical Thinking: Some Cognitive Components," Teachers College Record, No. 66 (April 1965), pp. 624-634.

[11] E. W. Eisner, "Critical Thinking: Some Cognitive Components," p. 626.

Eisner characterizes 'critical thinking' in terms of what he calls "four cognitive components."[12] The first component he calls "questing." Questing, according to Eisner, involves asking questions of a specific kind. One is not questioning if one is merely asking questions of clarification like "Miss Jones, did you say page 237 or 238?" One is questing if one is asking questions like "Why didn't the Black Muslims become Black Buddhists?" He asserts that such questing questions may be distinguished from other sorts of non-questing questions in that questing-questions "are catalytic to further inquiry." Critical thinking, therefore, in Eisner's view, begins with questing.

The second component he calls "speculation." Speculation, according to Eisner, is "the ability to generate models or theories to explicate phenomena."[13] The third component

[12] He does not claim to provide an exhaustive analysis, but it is useful to evaluate his suggestion as a definition to begin to see what such a definition is like.

[13] We can see that each of these components is very unclear. However, this unclarity seems to trap Eisner in his own account of speculation. He states that "If the students feel anxious or if they feel inadequate, if they feel their remarks will suffer critical evaluation, they tend to be less able to give free rein to those processes which make this behavior possible." He also points out that Osborn (in Applied Imagination: Principles and Procedures of Creative Thinking, N.Y. Scribners, 1953) has a standing rule prohibiting critical evaluation or critical comments during such speculation. I shall, however, assume that such speculations are not immune to the evaluation he mentions as the third component of critical thinking.

he calls "evaluation." Evaluation, according to Eisner, involves three distinct operations; first, evaluating the logic of propositions; secondly, evaluating the evidence supporting a claim; and thirdly, evaluating "the way in which language is organized, types of words selected, and the emphasis on certain words." The fourth component he calls "constructing." Constructing, according to Eisner, is the "production of relationships between seemingly unrelated concepts; the perception of elements as part of a larger whole."

Given Eisner's account, we might, therefore, expect that to say that someone is engaged in questing, speculating, evaluating and constructing is to say that that someone is engaged in critical thinking. Apparently these four components are meant conjunctively to describe or define 'critical thinking' since no component alone is sufficient to describe or define critical thinking, although he claims that each one is a necessary component.

Suppose someone asks "Why does grandmother dye her hair?", yet fails to suggest any reason why. This question appears to accord with Eisner's vague notion of a questing question. If we construe questing as a sufficient condition for critical thinking, asking this question is engaging in critical thinking. Yet our intuitions tell us that simply asking this question is not a sufficient condition for engaging in critical thinking.

One may generate models or theories, yet fail to engage in critical thinking. Suppose someone speculates that the Earth is round because God loves circles. We may claim that speculating in this sense is a sufficient condition for engaging in creative thinking, but not a sufficient condition for engaging in critical thinking.

We may grant that engaging in some suitably clarified notion of evaluation is sufficient for engaging in critical thinking, yet one may engage in what Eisner calls "constructing," producing relationships between seemingly unrelated concepts, and not engage in critical thinking. Suppose Stan claims that he is thinking of grandmothers and tuna fish.

A relationship between seemingly unrelated concepts like grandmothers and tuna fish, in this case is "grandmothers and tuna fish are both thought of by Stan." Yet we would not want to claim that in thinking of grandmothers and tuna fish, Stan is engaging in critical thinking. Therefore, producing these relationships is not a sufficient condition for engaging in critical thinking. To rule out the anticipated failure of these "components of critical thinking" to provide sufficient conditions for critical thinking, we might consider these components as jointly sufficient conditions for critical thinking. Therefore, a definition of 'critical thinking' in terms of these specific components evidencing specific behavior is as follows:

D.7 x is engaged in critical thinking iff x is engaged in questing and speculating and evaluating and constructing.

Assuming that these four components are clear, the first problem with Eisner's account and, consequently, with D.7, is that it is not exhaustive. There may be other components of critical thinking that are also jointly sufficient conditions for critical thinking. To provide this type of definition for 'critical thinking' is to attempt to provide an exhaustive account.[14]

Secondly, the notions of "questing, speculating, evaluating, and constructing" are sufficiently vague to include almost any thinking activity. Consequently, these notions do not

[14] He does not claim that his account is exhaustive, since he does not directly propose a definition, so criticism at this point is decidedly unfair. However, he does claim that these four cognitive components and their resulting behaviors "are considered important necessary aspects of critical thinking" but he adds "it is recognized that others may have made other selections."

usefully distinguish critical thinking from any other kind of thinking. These notions may, under certain circumstances, provide a jointly sufficient condition for the presence of what we preanalytically call critical thinking, but this does not help us to provide a definition of 'critical thinking'. These notions, under certain circumstances, provide a jointly conjunctively sufficient condition for critical thinking the same way that a bullet in the chest, under certain circumstances, provides a sufficient condition for death.[15] However, these notions, under no circumstances, provide a conjunctively necessary condition for critical thinking, the same way that a bullet in the chest, under no circumstances, provides a necessary condition for death.

To see that these four notions are not jointly necessary conditions for critical thinking, we must see that Eisner has not provided four correct necessary components of critical thinking.

[15] Consider a case in which x is engaged in questing, speculating, evaluating and constructing, each at different times and each about something different. We do not want to say, without reservation, that x is engaged in critical thinking. Therefore, we must carefully formulate the case in question. It is sufficient for my point, however, to grant that such a case may be successfully formulated.

Consider "questing." Certainly such questing questions may be catalytic to further inquiry, and the further inquiry may involve critical thinking. But it need not. There are many cases of what we want to call critical thinking that do not involve questing in Eisner's sense. Consider the following example.

Suppose that a knowledgable logician faces an argument with the following argument form: if P then Q; Q, therefore P. He need ask no questing questions to reply that this argument is invalid because it is an instance of an invalid argument form. He is sufficiently familiar with such simple argument forms to be able to evaluate them without asking "What could be wrong with this argument?," or "Why is this argument invalid?," or some other general question, construed as a questing question, catalytic to further inquiry.

Yet, because the logician has a high degree of familiarity with such simple arguments, and is able to evaluate them without asking a questing question, we do not want to say that he is not engaged in critical thinking. This would amount to claiming that at some degree N of familiarity with certain critical thinking operations, the operations cease to be critical thinking operations and become something else. Yet, we will want to be able to claim that someone is engaged in critical thinking, no matter what degree N of familiarity that that someone has with some critical thinking operation. Therefore, questing, as it now stands in Eisner's account, is not a necessary component of critical thinking.

Consider "speculation." Certainly engaging in speculation may engage one in critical thinking, but speculation is not a necessary component of critical thinking. Models or theories can be produced by insight, imagination, intuition, or methodical invention. As such, speculation is a kind of thinking, but it is mistaken to assume that every form of thinking is a form of critical thinking. There are cases of what we want to call critical thinking that do not involve speculation. Consider the following example. Suppose an environmentalist encounters the following argument:

1. If the reactor is built, then the river is polluted.
2. The river is polluted.
3. Therefore, the reactor is built.

He need not engage in speculation to think critically about this argument and to determine that it is invalid. To engage in critical thinking, the environmentalist need not engage in generating models or theories to explicate phenomena. Therefore, speculation is not a necessary component of critical thinking.

Consider "constructing." Certainly engaging in constructing may engage one in speculation and speculation may, in turn, engage one in critical thinking, but it need not. Constructing is not a necessary component of critical thinking. Relationships between seemingly unrelated concepts and between parts and wholes can be produced by accident, lucky guesses, intuitions or methodical invention. As such, constructing may be a form of thinking, but it is mistaken to assume that every form of thinking is a form of critical thinking. There are cases of what we want to call critical thinking that do not involve constructing. Consider the above example of the environmentalist. He need not engage in constructing to think critically about the argument and determine that it is invalid. To engage in critical thinking, the environmentalist need not engage in producing relationships between seemingly unrelated concepts, or between parts and wholes. Therefore, constructing is not a necessary component of critical thinking.

At most, what Eisner calls these four components of critical thinking provide, under certain circumstances, a conjunctively sufficient condition for the presence of our pre-analytic notion of critical thinking. Yet at least three of these components do not appear to be necessary components of critical thinking at all, nor do these four components provide a jointly necessary condition for the presence of critical thinking. For these reasons, D.7 does not appear to be a promising definition of 'critical thinking'. However, we may conclude that some notion of "evaluation" may be important in the attempt to define 'critical thinking' in terms of specific abilities, evidenced by specific behavior.

Robert Ennis also attempts to define 'critical thinking' in terms of abilities evidenced by specific behavior.[16] He adopts and revises a definition of 'critical thinking' suggested by B. O. Smith: "Now if we set about to find out what . . . (a) . . . statement means and to determine whether to accept it or reject it, we would be engaged in critical thinking."[17] Smith defines 'critical thinking' as "the assessing of statements." Ennis points out that Smith does not say "the correct assessing of statements" and that this allows Smith to talk about correct and incorrect critical thinking. Ennis, however, as a first step toward a definition of 'critical thinking', claims that 'critical thinking' should be defined such that one does not incorrectly engage in critical thinking. Rather, one simply

[16] R. Ennis, "A Definition of Critical Thinking", The Reading Teacher, No. 17 (March 1964), pp. 599-612.

[17] B. O. Smith, "The Improvement of Critical Thinking", Progressive Education, No. 30 (March 1953), pp. 129-134.

fails to engage in critical thinking. Ennis, therefore, proposes the following definition:

D.8 x is engaged in critical thinking iff x is engaged in the correct assessment of statements.

Ennis does not seem to be aware that D.8 as it stands will not do as a definition of 'critical thinking'. However, he points out that: a) "there are various kinds of statements," b) "There are various relations between statements and their support," and c) "there are various kinds of assessment." Yet he does not reformulate his definition, or clearly spell out the implications of a, b and c for D.8. He simply lists what he calls "nine major aspects of critical thinking based on the definition." We must now consider an objection to D.8 and then see how we can reformulate D.8 according to Ennis' suggestions in an attempt to form a workable definition of 'critical thinking'.

Consider the following counterexample, designed to expose the weakness of D.8. Suppose we program a computer to scan job applications for a large company, and to sort them into groups according to a statement of job description. The computer is in some sense engaged in the correct assessment of statements. It is correctly scanning the statement of job description and feeding the applications into the appropriate group. Yet we would not want to claim that the computer is engaged in critical thinking. D.8, therefore, does not provide a necessary and sufficient condition for critical thinking.

The obvious problem with D.8 is that it is too vague. We may reconstruct D.8 by appealing to Ennis' discussion of what he calls "nine major aspects of critical thinking." The nine major behavioral aspects of critical thinking, according to Ennis, are:

1. Judging whether a statement follows from the premises.
2. Judging whether a statement is an assumption.
3. Judging whether an observation statement is reliable.
4. Judging whether a simple generalization is warranted.
5. Judging whether a hypothesis is warranted.
6. Judging whether a theory is warranted.
7. Judging whether an argument depends on an ambiguity.
8. Judging whether a statement is vague or overspecific.
9. Judging whether an alleged authority is reliable.

We may begin our attempt to reformulate D.8 by eliminating the unnecessary reduplication among these nine aspects of critical thinking. First, 1 may be clarified to involve judging statements that follow from inductive arguments, statements that follow from deductive arguments, and statements that follow from neither inductive nor deductive arguments. With this clarification, 2, 4 and 5 can be included in this revision of 1. As it stands, 2 is difficult to understand. An assumption may be simply a statement which is taken to be self-evident, a statement which is generally believed to be true, or a statement which is offered without support. In any case, whatever an assumption is, this reformulation of 1 can include such statements, no matter how this vague term is construed; judging whether a statement is an assumption involves judging whether a statement, in fact, follows from neither inductive or deductive arguments, since no such arguments are presented.[18] Four is simply a case of judging whether a statement of a generalization follows inductively from some statement or set of statements as premises, and 5 is simply a case of judging whether there is any inductive or deductive support for the statement of a hypothesis. Three, 7, 8 and 9 involve judging whether a statement or a set of statements is an instance of an informal fallacy. Since these statements are somewhat unclear, some instances may be captured by a reformulation of 1. But we may also combine them under one heading and broaden that heading to include all forms of informal fallacies. This revised list of

[18] I shall assume here that any statement can be shown to follow deductively, even what have been called assumptions, since we may trivially provide a deductively valid argument with the assumption as the conclusion. (Assume that the roof will not fall. The deductive argument is that if Nixon was President, then the roof will not fall. Nixon was President. Therefore, the roof will not fall.) The point here, however, is recognizing that no such argument is, in fact, provided. This requirement can be built into any clarification of 1.

behavioral aspects of critical thinking mentioned by Ennis, therefore, is:

1. Judging whether a statement does or does not follow inductively from a presented statement or set of statements, or does or does not follow deductively from a presented statement or set of statements, or does not follow inductively or deductively from any presented statement or set of statements.
2. Judging whether a statement or a theory can be supported by sound arguments.
3. Judging whether a statement or set of statements commits an informal fallacy.

Each of these behavioral aspects involves, in turn, a set of abilities which presumably can be clearly enumerated. Therefore, we may consider adding these three behavioral aspects to Ennis' proposed definition in an attempt to reformulate D.8.

D.9 x is engaged in critical thinking iff x is engaged in correctly:

(1) judging whether a statement does or does not follow inductively from a presented statement or set of statements, or does or does not follow deductively from a presented statement or set of statements, or does not follow inductively or deductively from any presented statement or set of statements, or

(2) judging whether a statement of a theory can be supported by sound arguments, or

(3) judging whether a statement or set of statements commits an informal fallacy, or

any combination of doing (1), (2) and (3).

D.9 as a definition of 'critical thinking', is not immune to serious objection. The first objection to D.9 is that it seems to ignore an important aspect of critical thinking. One of the most important aspects of critical thinking is the ability to reformulate or clarify a term or a statement that may be unclear as it stands. If a term or a statement is unclear, then it may have a number of possible interpretations. The task, then, is to clarify the term or the statement in such a way that the interpretation selected makes explicit what the user of the term or the author of the statement could be reasonably construed to intend. This often involves applying what has been called the principle of charity.

D.9, for example, requires that we suppose in (2) that the statement of a theory is clear. However, one of the most important tasks of critical thinking is to provide a clear statement of a theory that is initially unclearly stated. This often involves explicating certain concepts used in the statement or clarifying the statement itself. The explanation of concepts and the clarification of statements can be loosely specified in terms of specific abilities. Thus, D.9 omits this important behavioral aspect of critical thinking. At most, D.9 provides, under certain circumstances sufficient conditions for critical thinking, but not both necessary and sufficient conditions.[19]

There is a second objection to D.9 to support this claim. Ennis argued that unlike Smith's definition of 'critical thinking', his definition of 'critical thinking' involved "correctly assessing statements," not simply "assessing statements." This implies that one cannot incorrectly engage in critical thinking, but that one simply fails to engage in critical thinking. This view, however, seems counterintuitive. For example, consider a philosopher laboring over a theory who publishes his defense of the theory in the Journal of Philosophy. Suppose that he is accused by a second philosopher, who publishes this attack on this defense of the theory in the next issue of the Journal of Philosophy, of supporting the theory with an unsound and an invalid argument. Suppose this second philosopher is correct. One complex argument is unsound, another complex argument is invalid. We might want to claim that the first philosopher failed correctly to support the theory, and consequently, engaged in incorrect critical thinking when reviewing his work, but we would not want to claim that in laboring over his theory and reviewing his

[19] This assumes that we can describe a case where statements, terms, etc. are clear, and that the case described avoids the other problems with D.9.

work, he failed to engage in critical thinking. Therefore, D.9 rules out instances of critical thinking that pre-analytically need to be ruled in.

A satisfactory definition of 'critical thinking' must succeed in ruling out activities which are obviously not instances of critical thinking, yet rule in activities which our intuitions strongly suggest are instances of critical thinking, even though they involve incorrect critical thinking. A satisfactory definition should rule in instances like the above philosopher reviewing his own work. If you are engaged in flying an airplane, but do it badly and crash, we cannot reasonably argue that you were never engaged in flying the airplane without distorting our intuitions. It is clearer to argue that you were engaged in flying the airplane badly.

There is a third objection to D.9 which can be seen by considering the following counterexample. Suppose in judging whether a statement of a theory can be supported by sound arguments (2), we lay a Coke bottle on its side and spin it. If the top points East, then the theory can be supported by sound arguments. If the top points West, then the theory cannot be supported by sound arguments. If the top points North, South, or anywhere in between, we spin the bottle again. Now suppose, in a particular case of a particular theory, the top points East, and we are correct. The theory in question can indeed be supported by sound arguments. Therefore, according to D.9, engaging in spinning the Coke bottle to make this judgment is engaging in critical thinking since D.9 does not specify how one must make a particular judgment like (2), or how the judgment made is to be supported. Making such a judgment by spinning a Code bottle, of course, is not what we want to call engaging in critical thinking. Therefore, D.9 is not a good definition of 'critical thinking'.

We can attempt to reconstruct D.9 to avoid these objections so that it might successfully provide both necessary and sufficient conditions for critical thinking. To attempt to avoid the third objection, we might distinguish what has, in the philosophy of science, been called the "context of discovery" from what has been called the "context of justification." The intuition here is that in considering necessary and sufficient conditions for critical thinking, we are not interested in the context of discovery, but only in the context of justification. Considerations of the context of discovery may more reasonably belong in discussions of what might constitute creative thinking.

The Coke bottle counterexample is addressed to the notion in D.9 of "correctly judging whether . . ." The effect seems to be that we may discover the correct judgment by accident, by lucky guess, by intuition, or by spinning a Coke bottle. This involves the context of discovery. None of these methods of discovering the correct judgment necessarily involve critical thinking. Discovery may involve creative thinking but that is of no concern here. The role of critical thinking, once such a discovery is made by whatever mysterious means, is, in this example, to support the judgment with reasoned arguments, applying the skills which are supposed to make up (1), (2) and (3). We must, therefore, state some conditions for justifying judgements like (1), (2), and (3) in a definition of 'critical thinking' such that these conditions avoid involving methods of discovering correct judgments and such that these conditions involve methods of justifying the judgment made which intuitively involve critical thinking abilities.

To attempt to avoid the second objection, we might simply eliminate 'correct' from the definition, since we want a definition which does not rule out all instances of critical thinking which turn out to be incorrect. To attempt to avoid the first objection, we might first introduce two other behavioral aspects of critical thinking and modify (2). We might introduce the following:

(4) judging whether a term or a statement is unclear

and requires explication or clarification.

(5) judging whether the proposed explicatum or the proposed clarification selected explicates or clarifies what the user of the term or the author of the statement can reasonably be construed to intend.

And modify (2) to read:

(6) judging whether a clear statement of a theory can or cannot be supported by sound arguments.[20]

Therefore, we may consider applying these suggestions in an attempt to reformulate D.9 and avoid these three objections:

D.10 x is engaged in critical thinking iff x is engaged in:

(1) a) judging whether a statement does or does not follow inductively from a presented statement or set of statements, or does or does not follow deductively from a presented statement or set of statements, or does not follow inductively or deductively from any presented statement or set of statements, and

b) x has the ability to produce an appeal to inductive or deductive rules of inference from which x believes the statement follows, or x has the ability to produce an appeal to inductive or deductive rules of inference that x believes are violated in concluding the statement, or x has the ability to provide an explanation that x believes explains why the statement does not follow inductively or deductively to support the judgment, or

[20] There is an objection to (2) related to the Coke bottle counterexample which might be avoided by stating some conditions for justifying judgments like (1), (2) and (3). The objection is does (2) require just deciding whether a theory can be supported by sound arguments, or actually supporting the theory with sound arguments?

(2) a) judging whether a term or a statement is unclear and requires explication or clarification, and

b) if x has the ability to produce what x believes to be more than one plausible construal of the meaning of the term or the meaning of the statement to support the judgment, or

(3) a) judging whether the proposed explicatum or the proposed clarification selected explicates or clarifies what the user of the term or the author of the statement can reasonably be construed to intend, and

b) x has the ability to produce an appeal to what x believes to be reasons for supposing that the proposed explicatum is, in fact, an explicatum (by appeal to what an explication is) or an appeal to what x believes to be reasons for supposing that the proposed clarification is, in fact, a clarification (by appeal to (2)) to support the judgment, or

(4) a) judging whether a clear statement of a theory can or cannot be supported by sound arguments, and

b) x has the ability to produce either what x believes to be a valid, sound deductive argument or what x believes to be a strong inductive argument to support the theory, or produce either what x believes to be a valid, sound deductive argument or what x believes to be a strong inductive argument to support its denial, to support the judgment, or

(5) a) judging whether a statement or a set of statements is an instance of an informal fallacy, and

b) x has the ability to produce the rule which x believes the fallacy in question is an instance of,

or any combination of doing (1), (2), (3), (4) and (5).

D.10 is a definition of engaging in critical thinking in terms of engaging in certain mental activities, as stated in (1) through (5) a), and in terms of having certain dispositions which may not be actualized, in terms of (1) through (5) b). As we have seen, just engaging in certain mental activities such as judging (in (1) through (5) a)) is not sufficient to define engaging in critical thinking. For example, we may engage in judging by lucky guess and not be engaged in critical thinking. Nor is just having certain dispositions which may not be actualized sufficient to define engaging in critical thinking. For example, we may have such dispositions while sleeping and not be engaged in critical thinking. However, defining engaging in critical thinking in terms of both engaging in certain mental activities and having certain dispositions which may not be actualized avoids these problems.

Consider (1) through (5). In each, a) simply requires a judgment, which may be arrived at even by spinning a Coke bottle. Therefore, a) alone does not rule out the possibility of a lucky guess, which does not involve engaging in critical thinking. However, (1) through (5) b) functions as a requirement which is meant to rule out such lucky guesses which do not involve engaging in critical thinking. These ((1) through (5) b)) require that x have the ability to produce a specific kind of justification that x believes to be adequate to support the judgments. Note that b) does not require certain behavior of x, but simply requires that x have certain dispositions to behave. These dispositions to behave are what serve to distinguish judging by lucky guess from judging by critical thinking.

For example, suppose that x judges that a statement does not follow deductively from a presented set of statements ((1) a)). Suppose that I, in fact, ask x to justify this judgment and he tells me to go to hell ((1) b)). In this case, suppose that x is simply busy, and thinks of me as a conceptual troublemaker, even though he, in fact, has the ability to justify the judgment by an appeal to the appropriate deductive rule of inference. According to D.10, in making this judgement, x is engaged in critical thinking since he still has the ability to justify the judgment, even though he has, in fact, told me to go to hell. In another case, suppose that x again tells me to go to hell; however, suppose that x does not, in fact, have the ability to justify the judgment by an appeal to the appropriate deductive rule of inference. According to D.10, x is not engaged in critical thinking since he does not have the disposition to justify the judgment by an appeal to the appropriate deductive rule of inference.

In another case, suppose that x makes this judgment, yet x is very drunk. Suppose x is, in fact, asked to justify this judgment, and x simply reaches into his pocket and pulls out a slip of paper on which is written "P · ∿ P" and says "it follows from this." According to D.10, x is engaged in critical thinking provided that x believes the given statement follows from the presented statement, or set of statements, according to this rule. If x simply reaches for this slip of paper out of habit and has no belief that the given statement follows from the presented statement or set of statements according to this rule, then according to D.10, x is not engaged in critical thinking.

However, D.10 rules in as instances of engaging in critical thinking certain instances that may involve incorrect critical thinking. For a definition of 'critical thinking', it seems intuitively virtuous to be able to understand that one is engaged in critical thinking, yet be able to decide independently that one is doing it badly. We can see this by seeing that (1) through (5) b) do not require that x have the ability to justify such judgments correctly. It seems intuitively clear that even if one were incorrectly to justify such a judgment, for example by appeal to an incorrect deductive rule of inference, in making the attempt, one would be engaged in critical thinking, even though incorrectly. In such a case, one would not clearly be engaged in any other activity, given the dispositional requirement stated in (1) through (5) b).

D.10, therefore, provides a general definition of what it is to engage in both correct and incorrect critical thinking. However, given an interest in eventually answering the question "Can critical thinking be taught?," we are less concerned with particular mental activities like judging D.10, (1) through (5) a), than with the question of whether by teaching we might instill the sort of dispositions and abilities required to justify such judgments, D.10 (1) through (5) b), by whatever means the original judgment is, in fact, made. Furtherfore, such a concern is not a concern for the actual dispositions that some person x happens to have when engaging in critical thinking, but rather a much more limited concern for the abilities that are necessary and sufficient for some person correctly to engage in critical thinking.

Having specified these specific disposition in terms of (1) through (5) b), we are now in a position to formulate a list of specific abilities which are necessary and sufficient for engaging correctly in critical thinking. This list will be useful for at least three purposes: first, to reformulate D.2 and provide a satisfactory definition of 'critical intelligence' in terms of the ability to engage correctly in critical thinking; secondly, to help determine if, or to what extent correct critical thinking, and thereby, critical intelligence, can be taught; and thirdly, to help guide the formulation of a curriculum for attempts to teach critical intelligence, if it is decided that it can be taught.

Given D.10, we may provide the following definition of the ability to engage correctly in critical thinking. Paralleling D.10,

D.11 x has the ability to engage correctly in critical thinking to degree N (for N > 0) iff x has the ability correctly to:

(1) perform deductive operations according to the rules of some deductive logical system that is both consistent and truth preserving, or perform inductive operations according to some rules of inductive support,[21] and x believes that the conclusions follow from the premises according to these rules to degree n1, or

(2) formulate plausible interpretations of a given statement or set of statements in which terms from the given statement or set of statements differ in meaning in the plausible interpretations, or a statement differs in meaning or truth value in the plausible interpretations, to degree n2, or

[21] While there are not, as yet, clearly justified principles of inductive support, there are clear cases of inductive support for which we do not, as yet, know the correct justified principles. It is beyond the scope of this work to provide such justified principles of inductive support, yet we can talk intelligibly about an ability to work correctly with some notion of inductive support, or evidence.

(3) determine that a proposed explicatum of a term used by an author or speaker, or a proposed clarification of a statement presented by an author or speaker is, in fact, an explicatum or is, in fact, a clarification to degree n3, or

(4) provide and evaluate deductive support (according to the rules of some deductive logical system that is both consistent and truth preserving) for given statements not necessarily translated into the language of that system, or to provide and evaluate inductive support (according to some rules of inductive support) for given statements; to degree n4, or

(5) recognize (psychologically persuasive) errors in informal reasoning that employs natural language, to degree n5,

or an combination of (1), (2), (3), (4) and (5), and

(6) $N = \frac{n1 + n2 + n3 + n4 + n5}{5}$

I shall now consider the abilities stated in D.11. I shall explain what it is to have these abilities, (1) through (5), to a certain degree n and how having these abilities to a certain degree n allows us to determine the degree N, (6), to which someone has the ability to engage correctly in critical thinking for $N > 0$.

The first disjunct of (1) is meant to capture the ability to perform deductive operations to evaluate given arguments by testing their validity with deductive systems of varying degrees of formality and sophistication, from simple syllogisms to the lower predicate calculus and quantified modal systems. The degree n1 to which one has the ability to perform these deductive operations is a function of the power of the system(s) known as well as the speed, reliability and economy with which one correctly performs these deductive operations.

The second disjunct of (1) is meant to capture the ability to discriminate among strong and weak inductive arguments by appeal to inductive rules; to determine by appeal to inductive rules if a presented statement requires more evidence to be judged highly probable or to determine by appeal to inductive rules if a presented statement is improbable, given the evidence offered to support it. The degree n1 to which one has this ability is a function of the speed, reliability and economy with which one correctly performs these inductive operations.

Disjunct (2) is meant to capture the ability to determine if a term or a statement is unclear in a given context by considering the logical and factual relationships among presented statements to, in turn, produce more than one plausible construal of the meaning or the term or the meaning or the truth value of the statement. The degree n2 to which one has this ability is a function of the speed, reliability and economy with which one correctly makes this determination.

Disjunct (3) is meant to capture the ability to evaluate a proposed explication of a term or a proposed clarification of a statement by determining (by appeal to the rules of explication) that the explicatum is, in fact, an explicatum or by determining (by appeal to (2)) that the proposed clarification is, in fact, a clarification of the statement. The degree n3 to which one has this ability is a function of the speed, reliability and economy with which one correctly makes this determination.

Disjunct (4) is meant to capture the ability to evaluate a clear statement of a theory by performing deductive operations on statements of the theory or providing deductive arguments to support the theory or to refute the theory, translating statements into a formal language to prove that the theory is consistent or to show that it is inconsistent, or to prove that the arguments supporting the theory are valid or to show that they are invalid, or by performing inductive operations to support the theory or to refute the theory, or providing inductive arguments to support the theory or to refute the theory. The degree n4 to which one has this ability is a function of the speed, reliability and economy with which one correctly evaluates such statements.

Disjunct (5) is meant to capture the ability to recognize informal fallacies in reasoning that employs natural language by citing the error in reasoning that the fallacy commits. The degree n5 to which one has this ability is a function of the speed, reliability and economy with which one correctly recognizes such fallacies.

Disjunct (6) is meant to account for degrees of ability to engage correctly in critical thinking. According to (6), the degree N to which x has the ability to engage correctly in critical thinking is the average of the sum of the degrees n1 through n5 to which x has the ability correctly to engage in (1) and (2) and (3) and (4) and (5). Since we have no clear reason to suppose that one of these dispositions is more important for critical thinking than any other, all are weighted equally for determining the degree N of the ability to engage correctly in critical thinking. In this way, then, D.11 allows us to talk of one improving one's ability to engage correctly in critical thinking, or of having the ability to a greater or lesser degree than someone else who also has the ability.

According to D.11 (1), x may be said to have an ability to perform deductive operations if x knows some simple rules of syllogism and takes hours to evaluate the validity of simple deductive arguments. However, x is said to have this ability to a lower degree nl than someone else who can perform the operations quickly, reliably and economically. Similar considerations apply to (2), (3), (4) and (5). One who can only do (1), even to a fairly high degree nl, who cannot do (2), (3), (4) or (5), is said to have the ability to engage correctly in critical thinking since in D.11, (1) is a sufficient condition for such an ability. Yet according to D.11 (6), he may be said to have the ability to a very low degree N.

Given D.11, we may now reconsider D.2 as a definition of 'critical intelligence'. D.2 was unacceptable because 'critical thinking' was as unclear a term as 'critical intelligence'. Now, however, we have a definition of 'critical thinking' in terms of D.10. Yet as it stands, D.2 is still unacceptable because critical intelligence seems to admit of degrees, yet D.2 does not allow us to account for degrees of critical intelligence. D.2 is also unacceptable because according to D.10, one may engage in critical thinking, yet do so incorrectly. It is not satisfactory to say that someone is critically intelligent when that someone engages incorrectly in critical thinking.

However, given D.11 as a definition of the ability to engage correctly in critical thinking to degree N, we may reformulate D.2 to avoid these objections and to provide an acceptable definition of 'critical intelligence':

D.12 x is critically intelligent to degree N (for N > O) iff x has the ability to engage correctly in critical thinking to degree N (for N > O) (as defined by D.11).

D.12 allows us to account for the degree N of critical intelligence in terms of the degree N of the ability to engage correctly in critical thinking as specified in D.11. This degree N is, in turn, accounted for in D.11 by determining and considering the degrees n to which one has the ability to engage correctly in (1), (2), (3), (4) and (5). D.10 allows us to understand what it is to engage in critical thinking, either correctly or incorrectly.

With these notions clarified in answer to question 1, we are now in a clearer position both to determine if or to what extent critical intelligence, as defined by D.12, can be taught in answer to question 3 and to formulate a curriculum for attempts to teach critical intelligence if it is decided that it can be taught, in answer to question 4. First, however, we must attempt to understand the notion of teaching and answer question 2, "What is teaching?"

CHAPTER II

WHAT IS TEACHING?

Many educators, educational psychologists and philosophers of education have provided descriptions of teaching which may, in turn, be reformulated as defintions of 'teaching'. However, these many descriptions seem to fall into at least four distinct groups when reformulated as definitions of 'teaching'.[22] The first group of definitions are attempts to define 'teaching' in terms of some method or methods. The second group of definitions are attempts to define 'teaching' in terms of some specific action or sets of actions. The third group of definitions are attempts to define 'teaching' in terms of directing learning, while the fourth group of definitions attempt to define 'teaching' as a kind of intentional performance. In each group, many of the suggested definitions are very similar. Rather than consider every definition offered, I shall consider

[22] Each definition among the groups of definitions that I consider critically make some reference to the notion of learning, so distinguishing a group of definitions of 'teaching' that make reference to learning does not usefully individuate any such definitions. I shall later point out that taking 'learning' as a primitive term in the definiens of a definition of 'teaching' is not useful for my purpose here because then to ask "Can critical intelligence be taught?" is to ask in some form "Can critical intelligence be learned?", and without a thorough explication of 'learning', we simply substituted one obscure question for another.

a representative sample from each of the four groups in an attempt to formulate a satisfactory definition of 'teaching'.

Definitions of 'Teaching': Group One

In his account of teaching, B. F. Skinner specifies the goal of teaching in terms of learning; "Teaching is the expediting of learning; a person who is taught learns more quickly than one who is not."[23] Yet clearly, according to Skinner, teaching is not a necessary condition of learning:

> "Teaching is simply the arrangement of contingencies of reinforcement. Left to himself in a given environment, a student will learn, but he will not necessarily have been taught. The school of experience is not school at all, not because no one learns in it, but because no one teaches."[24]

Skinner specifies what he takes to be the most significant aspect of teaching. "A student is taught in the sense that he is induced to engage in new forms of behavior and in specific forms upon specific occasions."[25] Yet not just any form of behavior will do in Skinner's account.

[23] B. F. Skinner, The Technology of Teaching, (N.Y., Appleton-Century-Crofts, 1965), p. 5.

[24] B. F. Skinner, The Technology of Teaching, p. 5.

[25] B. F. Skinner, The Technology of Teaching, p. 33.

"Inducing a student to behave in a given way is not teaching."[26] Skinner is concerned to limit what he takes to be the most significant aspect of teaching to include learning behavior, since in his view, teaching involves the expediting of learning.

To explain what he takes to be the most significant aspect of teaching and the relationship of teaching to learning, Skinner applies his notion of operant conditioning. He claims that:

> "The application of operant conditioning to education is simple and direct. Teaching is the arrangement of contingencies of reinforcement under which students learn. They learn without teaching in their natural environments, but teachers arrange special contingencies which expedite learning, hastening the appearance of behavior which would otherwise be acquired slowly or making sure of the appearance of behavior which might otherwise never occur."[27]

Skinner, therefore, explains the relationship of teaching and learning by claiming that teaching is a sufficient condition for learning, although teaching is not a necessary condition for learning.

[26] B. F. Skinner, The Technology of Teaching, p. 223.

[27] B. F. Skinner, The Technology of Teaching, pp. 65-65.

Given Skinner's specification of the goal of teaching, his account of what he takes to be the most significant aspect of teaching, and his explanation of the relation of teaching and learning, we may formulate the following definition of 'teaching' on Skinner's behalf:

D.13 x is engaged in teaching y Ø iff x is engaged in inducing y's learning Ø by arranging contingencies of reinforcement to expedite y's learning Ø.

Like most definitions of 'teaching' in group one, D.13 confuses the way in which teaching is or can be performed with a definition of 'teaching'. Consider the following counterexample. Suppose that PBS broadcasts a lecture by a noted horticulturist on the process of organically raising tomatoes. The television lecture does not contain the contingencies of reinforcement. He simply explains the process of organically raising tomatoes. Yet we intuitively would like to be able to claim that the horticulturist is engaged in teaching the process of organically raising tomatoes to the TV audience. For example, when one walks into a room and asks one viewing the broadcast "What is that man doing?," one would like to be able to reply "Teaching us the process of organically raising tomatoes." Therefore, inducing learning by arranging contingencies of reinforcement to expedite learning is not a necessary condition for engaging in teaching.

We may grant that in some cases inducing learning by arranging contingencies of reinforcement to expedite learning is engaging in teaching, but only by trading the unclarity of 'teaching' for the unclarity of 'learning'. D.13 rules out cases of arranging contingencies of reinforcement for y's that cannot learn. But this assumes that we can make a clear distinction between y's that can learn and y's that cannot learn in order to distinguish those y's one can engage in teaching from those y's that one cannot engage in teaching. One may arrange contingencies of reinforcement to modify a worm's behavior, but is that to say that worms can learn? Are we, thereby, engaged in teaching worms? The answer seems to depend on an account of learning.

Consider a case in which y is a person who can learn. Suppose an expert in torture is engaged in inducing y's learning that he must cooperate with his captors by arranging tortures to expedite y's learning that he must cooperate with his captors. Is engaging in torturing y engaging in teaching y? One might reply no, since y cannot be truly said to learn in such a case, or one might reply yes, torturing is teaching since y learned some $\emptyset$, namely that he must cooperate with his captors. Yet answering this question involves appealing to some definition of 'learning'. D.13, in this case, simply trades the unclarity of 'teaching' for the unclarity of 'learning' and is not a successful definition of 'teaching'.

John Brubacher presents what he calls a definition of 'teaching' that also can be construed as an attempt to define teaching in terms of some method.[28] Brubacher argues that to teach means to "arrange and manipulate a situation in which there are gaps or obstructions which an individual will seek to overcome and from which he will learn in the course of doing so."[29] To explain his definition he appeals to his discussion of the relation between problem solving and learning. He argues that if one seeks to solve a problem, then one learns both by seeking and by solving.[30]

In Brubacher's view, therefore, teaching is a sufficient condition for learning, since teaching is defined in terms of setting up such problem solving situations which an individual will seek to solve. However, he also claims that

[28] J. Brubacher, Modern Philosophies of Education, (N.Y.: McGraw Hill, 1939).

[29] J. Brubacher, Modern Philosophies of Education, p. 108.

[30] J. Brubacher, Modern Philosophies of Education, p. 105.

learning may occur without teaching. In Brubacher's view, therefore, teaching is not a necessary condition for learning.

Given Brubacher's account of teaching and its relation to learning, one may formulate the following definition on Brubacher's behalf:

D.14 x is engaged in teaching y Ø iff x is engaged in arranging and manipulating problem situations such that y will seek to solve the problem, and in so doing, y learns Ø.

D.14, however, provides neither a necessary nor a sufficient condition for teaching and, therefore, also fails as a definition of 'teaching'. Suppose that x is engaged in teaching y how to tune an antique auto engine. Now x _may_ choose to do so by arranging and manipulating problem situations, but x _need not_ choose this method to teach y how to tune his engine. Instead, x may simply explain the physical laws governing the operation of any internal combustion engine, the mechanical principles of such engines, and the engineering decisions applying these laws and principles in x's antique engine. Then x may simply explain the procedure for maintaining the most efficient operation of these laws and principles given these specific engineering decisions. In this case, x can be said to be engaged in teaching y how to tune his auto engine. Yet, x cannot be said to be engaged in arranging and manipulating problem situations for y to overcome so that y will learn to tune his antique auto engine. X has simply been engaged in explaining physical laws, mechanical principles, and specific engineering decisions. Therefore, D.14 does not provide a necessary condition for teaching.

Now suppose that y is driving an antique auto down a lonely stretch of highway to deliver it to a man who will pay him only if he can deliver it before 5:00. The auto sputters to a halt. Furthermore, y allowed 30 minutes to make the 20-minute trip so that y has 10 minutes to solve the problem, to arrive before 5:00, and to make the sale. In carefully examining the engine, y learns that there is no gas in the carburetor and traces the problem back to a dirty fuel filter. He removes and cleans the filter, and motors on to make the sale.

Only in an odd and metaphorical sense could one claim that the antique auto taught y that its fuel filter was dirty since ordinarily cars are not the kinds of things that engage in teaching, nor do they arrange and manipulate situations. First, suppose that it was y who desired to sell the auto and gave himself the time limit, failed earlier to inspect the fuel filter, and thereby arranged and manipulated (even if unknowingly) the problem situation he sought to solve. Yet it is also odd that y taught himself that the antique auto engine's fuel filter was dirty. Brubacher has argued that one may learn without being taught and this seems to be such a case; y learned that the antique auto engine's fuel filter was dirty, although no one taught him that it was dirty.

Secondly, suppose it was x, the car's owner, who hired y to deliver the car. Then x desired to sell the auto, gave y the time limit, failed earlier to inspect the fuel filter and thereby arranged and manipulated (even if unknowingly) the problem situation y sought to solve. Yet it is also odd to say that x taught y that the antique auto engine's fuel filter was dirty. Therefore, x may be engaged in arranging and manipulating problem situations such that y will seek to solve the problem, and, in so doing, learn Ø, and yet x may not be engaged in teaching. Therefore, D.14 does not provide a sufficient condition for teaching. Therefore, D.14 fails as a definition of 'teaching'.

Definitions of 'Teaching': Group Two

B. Othanel Smith argues that not only can one learn without being taught, but also that:

> "Learning does not necessarily issue from teaching; that teaching is one thing and learning is quite another is significant for pedagogical research. It enables us to analyze the concept of teaching without becoming entangled in the web of arguments about the processes and conditions of learning. In short, to carry on investigations of teaching in its own right."[31]

Smith then carries out his own investigation of teaching and offers his own account. He argues that "teaching is a system of actions directed to pupils."[32] He claims that "these actions are varied in form and content and they are related to the behavior of pupils whose actions are, in turn, related to those of the teacher."[33]

Smith then distinguishes a teacher's verbal and a teacher's non-verbal actions, and claims that these actions are necessary conditions for teacher-induced learning, yet not sufficient conditions for teacher-induced learning. Nor, he claims, are they necessary or sufficient conditions for any non-teacher induced learning. Yet these actions may be construed, according to Smith, as necessary and sufficient conditions for engaging in teaching.[34]

[31] B. O. Smith, "A Concept of Teaching," <u>Teacher's College Record</u>, Vol. 61, No. 5 (Feb. 1960), p. 233.

[32] B. O. Smith, "A Concept of Teaching," p. 233.

[33] B. O. Smith, "A Concept of Teaching," p. 233.

[34] B. O. Smith, "A Concept of Teaching," pp. 233, 236.

Smith lists these verbal actions as defining, classifying, explaining, conditional inferring, comparing and contrasting, valuating, designating, correcting performance errors, directing, and admonishing. Smith lists these non-verbal actions as showing or expressing non-verbal signs of approval or disapproval.[35]

Given his account of teaching and its relation to learning, we may formulate the following definition of 'teaching' on Smith's behalf:

D.15 x is engaged in teaching y Ø iff x is engaged in performing the actions necessary for y to learn Ø, which is for x to engage in performing

(1) verbal actions such as defining, classifying, explaining, conditional inferring, comparing and contrasting, valuating, designating, correcting performance errors, directing, demonstrating, or

(2) non-verbal actions such as showing or expressing non-verbal signs of approval or disapproval

for y to learn Ø.

According to D.15, one is engaged in teaching if and only if one is engaged in performing the actions Smith claims are necessary conditions for teacher-induced learning. Thus, according to D.15, performing these actions is a necessary and a sufficient condition for engaging in teaching.

[35] B. O. Smith, "A Concept of Teaching," pp. 237-240.

One may grant that these actions are disjunctively necessary conditions for teacher-induced learning, yet they avoid counterexamples only because they are sufficiently vague to do so. One may, therefore, grant that because of their vagueness, these actions provide disjunctively necessary conditions for engaging in teaching. However, because of their vagueness, engaging in these actions is not a sufficient condition for engaging in teaching. Therefore, D.15 fails as a definition of 'teaching'.

Consider the verbal action (1) in D.15. Suppose that a lexicographer writes the definition of 'spelunker'. Suppose that he writes the dictionary simply to make money and that his is the only dictionary to include 'spelunker'. Ten years later, a student looks up 'spelunker' and learns its meaning. Clearly the lexicogrpaher was engaged in performing the actions necessary for the student to learn the definition of 'spelunker'. However, in performing those actions, the lexicographer was not engaged in teaching the student the meaning of 'spelunker'; he was simply engaged in writing a dictionary to earn money. Therefore, engaging in the action of defining for y to learn Ø is not sufficient condition for engaging in teaching y Ø. Suppose that a medical officer at a draft physical examines a prospective inductee, and finding that he has no left leg, classifies him 4-F. Engaging in classifying the prospective inductee 4-F is not engaging in teaching, even if the prospective inductee learns that he is classified 4-F. Therefore, engaging in the action of classifying for y to learn Ø is not sufficient condition for engaging in teaching y Ø. Suppose that a clerk at a clothing store explains to a customer that he owes another $13.00 to cover alterations on a pair of $80.00 slacks. Engaging in explaining to a customer that he owes another $13.00 is not engaging in teaching, even if the customer learns that he owes another $13.00. Therefore, engaging in the action of explaining for y to learn Ø is not a sufficient condition for engaging in teaching y Ø. Suppose that Gerald Ford, in a speech to the leaders of AIM, conditionally infers "If the Moon is green cheese, then I am not an Indian." Engaging in conditionally inferring "I am not an Indian" from "the Moon is green cheese" is not engaging in teaching, even if the leaders of AIM learn that Ford is not an Indian. Therefore, engaging in the action of conditionally inferring for y to learn Ø is not a sufficient condition for engaging in teaching y Ø. Suppose that a car salesman is comparing, contrasting, and valuating two different used cars for a prospective customer. Engaging in comparing, contrasting and valuating two used cars is not engaging in teaching, even if the prospective customer learns that one car is a better buy than the other. Therefore, engaging in the actions of comparing, contrasting or valuating is not a sufficient condition for engaging in teaching y Ø. Suppose that Bart Starr designates Bill Cooke as a starting offensive tackle. Engaging in designating Bill Cooke a starting offensive tackle is not engaging in teaching, even if Bill Cooke learns that he is a starting offensive tackle. Therefore, engaging in designating is not a sufficient condition for engaging in teaching. Suppose that David Pearson's Mercury is running roughly on a test lap before the Daytona 500, and he drives into the pits to let the Wood brothers correct the performance error. Engaging in correcting the performance error in David Pearson's Mercury is not engaging in teaching, even if Pearson learns that the carburetor restrictor plate was dirty, causing the rough running. Therefore, engaging in correcting performance errors is not a sufficient condition for engaging in teaching y Ø. Suppose that a traffic cop is directing traffic around the scene of a rush-hour accident. Engaging in directing traffic is not engaging in teaching, even if groups of motorists learn when to stop and when to proceed. Therefore, engaging in directing is not a sufficient condition for engaging in teaching y Ø. Suppose that a group of Washington secretaries are demonstrating their secretarial skills before the House Ethics Committee. Engaging in demonstrating secretarial skills is not engaging in teaching, even if the Congressmen learn that no Washington secretaries can type. Therefore, demonstrating is not a sufficient condition for teaching y Ø.

Consider the non-verbal actions (2) in D.15. Suppose that Grandpa Larkin is arrested for exposing himself to a group of Girl Scouts. Engaging in showing is not engaging in teaching, even though the Girl Scouts learn something about geriatric biology. Therefore, showing is not a sufficient condition for teaching y Ø. Suppose that Rick Reichardt strikes out and the Kansas City fans express non-verbal signs of disapproval by silently standing and extending their middle fingers. Engaging in expressing non-verbal signs of disapproval is not engaging in teaching, even if Reichardt learns that he should retire from baseball. Therefore, expressing non-verbal signs of approval or disapproval is not a sufficient condition for teaching y Ø. Therefore, D.15 fails as a definition of 'teaching'.

Paul Komisar is concerned to provide a definition of teaching in terms of what he calls teaching acts. In doing so, he is concerned to rule out "indoctrinating, training, propagandizing, preaching, insinuating, deceiving, counseling, and moralizing" as teaching acts.[36] In an attempt

[36] P. Komisar, "Teaching: Acts and Enterprise," Studies in Philosophy and Education, No. 6 168-193, (Spring 1968), p. 179.

to define 'teaching' and to rule out the above, he distinguishes, among teaching acts, what he calls learning-donor acts, learner-enhancing acts and intellectual acts. He spells out learning-donor acts as "acts intended to contribute rather directly and pointedly to the production of learning, such as prompting, cueing, reinforcing, drilling, censuring or censoring, showing, etc."[37] Learning-donor acts, therefore, have this specific goal. Learner-enhancing acts are "acts intending to put or maintain the learner in a fit state to receive instruction . . . to reduce anxiety, alleviate perceptual difficiencies, arouse interest, focus attention, and other ego-strengthening acts."[38] Learner-enhancing acts, therefore, have this specific goal.

Intellectual acts, according to Komisar, are acts such as "introducing, demonstrating, citing, reporting, hypothesizing, conjecturing, confirming, contrasting, explaining, providing, characterizing, justifying, explaining, defining, rating, appraising, amplifying, vindicating, interpreting, indicating, instancing, elaborating, identifying, designating, and comparing."[39]

[37] P. Komisar, "Teaching: Acts and Enterprise," p. 180.

[38] P. Komisar, "Teaching: Acts and Enterprise," pp. 180-181.

[39] P. Komisar, "Teaching: Acts and Enterprise," p. 181.

Given his account of teaching acts, in terms of learning-donor acts, learner-enhancing acts and intellectual acts, we may formulate the following definition of teaching on Komisar's behalf:

D.16 x is engaged in teaching y Ø iff x is engaged in performing actions intended to:

(1) contribute directly and pointedly to the production of y's learning Ø such as prompting, cueing, reinforcing, drilling, censuring or censoring, approving or showing, or other learning-donor acts, and

(2) put or maintain the learner y in a fit state to receive instruction for Ø, such as reducing anxiety, alleviating perceptual deficiencies, arousing interest, focusing attention, or other ego-strengthening learner-enhancing acts, and

(3) introduce, demonstrate, cite, report, hypothesize, conjecture about, confirm, contrast, explain, prove, characterize, justify, define, rate, appraise, amplify, vindicate, interpret, indicate, instance, elaborate, identify, designate, or compare Ø for y.

However, Komisar's attempt to distinguish three kinds of teaching acts to rule out indoctrination, training, propagandizing, preaching, insinuating, deceiving, counseling, moralizing, etc., and to rule in teaching, is unsuccessful. To reflect Komisar's attempt to rule out these non-teaching actions and to rule in only teaching actions, (1), (2) and (3) are conjunctive elements in D.16. However, consider the following counterexample.

Suppose that an insane individual, whose mind has been destroyed by drugs, performs acts intended to contribute rather directly and pointedly to the production of his nurse learning first order logic and performing actions intended to put or maintain the nurse in a fit state to receive instruction, and performing actions intended to introduce, demonstrate, cite, report, hypothesize, conjecture about, confirm, contrast, explain, prove, characterize, justify, define, rate, appraise, amplify, vindicate, interpret, indicate, instance, elaborate, identify, designate, or compare first order logic for the nurse. However, while having these intentions, this insane individual actually engages in physically assaulting the nurse, while screaming obscenities at her. According to D.16, having these goals in mind (having the above intentions for his actions)[40] requires us to say that this insane individual is engaged in teaching his nurse first order logic. However, he is engaged in physically assaulting the nurse, while screaming obscenities at her, and is not engaged in teaching her first order logic. Therefore, D.16 fails to provide a sufficient condition for 'teaching' and, therefore, fails as a definition. Having such intentions may be necessary for engaging in teaching, but it is certainly not sufficient.

[40] This anticipates my brief account of intentions on pages 73 and 74.

Definitions of 'Teaching': Group Three

In his influential book, How We Think, John Dewey presents his views on the nature of teaching and its relationship to learning. Dewey describes the teacher as a leader, and teaching as a kind of leading.

> "In reality, the teacher is the intellectual leader of a social group. He is a leader, not in virtue of official position, but because of wider and deeper knowledge and matured experience."[41]

As an intellectual leader, the teacher, according to Dewey, "determines the educational purpose to be carried out."[42]

To be an intellectual leader, or a teacher, one must satisfy certain conditions. According to Dewey, one needs abundant knowledge, "abundant to the point of overflow. It must be wider than the ground laid out in the textbook, or in any fixed plan for teaching a session."[43] One must also,

[41] John Dewey, How We Think (Revised Edition, N.Y.: Heath, 1934), p. 275-76.

[42] John Dewey, How We Think, p. 275.

[43] John Dewey, How We Think, p. 275.

[44] John Dewey, How We Think, p. 275.

according to Dewey, "have his mind free to observe the mental responses and movements of the student members of the recitation group. The problem of the pupils (learning) is found in the subject matter; the problem of the teachers (teaching) is what the minds of the pupils are doing with this subject matter."[44] Dewey also requires technical or professional knowledge, including a basic knowledge of human psychology and "educational methods found helpful by others teaching various subjects."[45] However, Dewey adds that "unfortunately this professional knowledge is sometimes treated not as a guide and tool in personal observation and judgment . . . but as a set of fixed rules of procedure in action."[46]

> "Finally, the teacher, in order to be a leader (and thereby be a teacher), must make special preparation for particular lessons. Otherwise, the only alternatives will be either aimless drift or else sticking literally to the text. The teacher must ask beforehand: what do the minds of the pupils bring to the topic from their previous experience and study? How can I help them make connections? What need, even if unrecognized by them, will furnish a leverage by which to move their minds in the desired direction? What uses and applications will clarify the subject and fix it in their minds? How can the topic be individualized?"[47]

[45] John Dewey, How We Think, p. 276.

[46] John Dewey, How We Think, p. 276.

[47] John Dewey, How We Think, p. 277.

Dewey also recognizes that learning and teaching are distinct concepts, yet he is concerned to relate them.

> "Teaching may be compared to selling commodities. No one can sell unless someone buys. We should ridicule a merchant who said that he had sold a great many goods, although no one had bought any. But perhaps there are teachers who think that they have done a good day's teaching, irrespective of what pupils have learned. There is the same exact equation between teaching and learning that there is between selling and buying. The only way to increase the learning of pupils is to augment the quantity and quality of real teaching. Since learning is something that the pupil has to do by himself and for himself, the initiative lies with the learner. The teacher is a guide and director; he steers the boat, but the energy that propels it must come from those who are learning."[48]

Again, in Dewey's view, teaching is not necessary for learning. Yet if one is engaged in teaching, then the one taught must learn. In Dewey's account, teaching is a sufficient condition for learning, and learning is a necessary condition for teaching.

Given Dewey's account of teaching as intellectual leading and his account of the relation of teaching and learning, we may formulate the following definition of 'teaching' on Dewey's behalf.

D.17 x is engaged in teaching y Ø iff x is engaged in intellectually leading y such that x directs y's

[48] John Dewey, How We Think, pp. 35-6.

successful learning of Ø, and if x intellectually leads y to Ø, then y learns Ø, and x intellectually leads y to Ø only if y learns Ø, where x is intellectually leading y to learn Ø iff x has more abundant knowledge of a particular subject which includes Ø than y, and x is free to observe y's mental responses and movements, and x has knowledge of psychology and past successful educational methods such that x may apply this knowledge as a guide and tool in personal observation and judgment of y, and x makes special preparations for particular lessons leading y to Ø.

D.17 is an interesting definition in that it attempts to provide an account which takes seriously the relation of teaching and learning. However, D.17 fails adequately to account for the relation of teaching and learning by failing adequately to account for teaching as an intentional activity. However, before considering this definition, a brief discussion of intentional action is in order.

Providing a clear account of the notion of an intentional action is a notoriously difficult philosophical task. However, for the discussion of teaching as an intentional activity which is to follow, it is sufficient to point out that intuitively, intentional activities are activities undertaken with some purpose or goal in mind for doing the activity. An action performed without some purpose or goal in mind for doing the action is not an intentional action. Therefore, if x is an action, then one may be said to do x intentionally only if one does x with some definitely formulated purpose or goal in mind for doing x. Note that while this is a necessary condition for intentional actions, it is not a sufficient condition. Nor does doing x intentionally mean that one actually accomplishes what one intended in doing x. While this is by no means a complete account of the notion of an intentional action, noting the above necessary condition will clarify what I shall mean by an intentional action in this discussion of teaching.[49] We must now consider D.17 and see how it fails adequately to account for teaching as an intentional activity.

Suppose that a swimming instructor is working with a class of beginning swimmers. The class has been meeting daily for three weeks and still no one in the class has learned to swim. According to D.17, the instructor is not engaged in teaching the class. A proponent of D.17 may defend the conclusion that the instructor is not engaged in teaching the class by arguing that instead he is engaged in failing to teaching the class.

However, to advance such an argument in defense of D.17 is to miss an important distinction between intentionally and unintentionally failing to teach. Suppose that the

[49] This notion gets very complex very quickly. For a definitive discussion of intentional action, see Reason and Action, a manuscript by Bruce Aune, to be published by the Rydell Press. See, especially, revised "Chapter Two: The Springs of Action", p. 61-126-17a, p. 65-76a, and p. 106-115.

instructor were engaged in failing to teach the class how to swim. If his supervisor came to him and asked "What are you doing?", we should expect him to answer "Trying to teach them to swim but failing." We should not expect him to answer "Trying to fail to teach them to swim." With the first reply, the instructor has a better chance of keeping his job than with the second. Clearly the instructor reveals an acceptable goal to the supervisor in the first reply, but reveals an unacceptable goal to the supervisor in the second reply.

To use Dewey's example, the two senses of engaging in failing to teach may be compared to two senses of engaging in failing to sell. If one is actually engaged in failing to sell, one may do so intentionally or unintentionally. Suppose that a salesman does not intend to sell a valuable rug because he intends to buy it himself. When would-be customers arrive, we may say that the salesman is engaged in trying to fail to sell the rug. However, this is quite different from engaging in trying to sell the rug, but failing.

Being engaged in trying to fail to teach is distinct from being engaged in trying to teach but failing, much like being engaged in trying to fail to sell is distinct from being engaged in trying to sell, but failing. We must be sure that when we claim that the swimming instructor is not engaged in teaching, but rather engaged in failing to teach, that we carefully consider the instructor's intentions; the definitely formulated purpose or goal he has in mind for doing his teaching. Simply being actually engaged in failing to teach is not a clear activity, given a concern for teaching as an intentional activity.

To say that someone is simply engaged in teaching seems to be to say that someone is either engaged in trying to teach, or engaged in succeeding to teach. It is not to say that someone is engaged in trying to fail to teach, since this is a distinct activity. Yet D.17 fails adequately to distinguish these activities by failing adequately to consider the question of intentions in the relations of teaching and learning. Consider the following counterexample. Suppose that a bureau chief in a government bureaucracy is charged by a superior with teaching an efficiency expert the inner workings of his bureau. The bureau chief is insecure, fears losing his job, and also fears that the efficiency expert will discover that his job is eliminable. The chief must appear cooperative, yet intends to try to fail to teach the efficiency expert the inner workings of his bureau in order to save his job. Yet the efficiency expert is smart and insightful, and although unintentionally, the bureau chief directs the expert's learning the inner workings of his bureau, and the expert learns them. The bureau chief has a more abundant knowlege of survival in bureaucracies, which includes a knowledge of the inner workings of his bureau, than does the efficiency expert; he is free to observe the expert's mental responses and movements, he has a knowledge of psychology and past successful educational methods, and applies this knowledge as a guide and tool in personal observations and judgment of the expert in his attempt to try to fail to teach the expert, and he makes special preparations for particular lessons, reviewed by his superior, leading the expert to learn the inner workings of his bureau, although he does not intend that he learn them.

Clearly, the bureau chief is engaged in trying to fail to teach the efficiency expert the inner workings of his bureau, and not simply engaged in teaching. Nor is failing to fail to teach the same intentional activity as succeeding to teach. Yet, according to D.17, the bureau chief is engaged in teaching the efficiency expert the inner workings of his bureau. Therefore, D.17 fails to account for the role of intentions in the relation between teaching and learning. The efficiency expert learned the inner workings of the bureau in spite of the bureau chief. Therefore, D.17 is not an adequate definition of 'teaching'. One must more carefully consider intentions in such a definition.

Definitions of 'Teaching': Group Four

Israel Scheffler attempts carefully to consider intentions in proposing an account of 'teaching'. In "Philosophical Models of Teaching,"[50] Scheffler gives a brief characterization of teaching which is amplified in his book The Language of Education.[51] In the article he briefly chacterizes teaching as follows:

> "Teaching may be characterized as an activity aimed at the achievement of learning and practiced in such a manner as to respect the student's intellectual integrity and capacity for independent judgment. Such a characterization is important for at least two reasons: first, it brings out the intentional nature of teaching, the fact that teaching is a distinctive goal-oriented activity, rather than a distinctively patterned sequence of behavioral steps executed by the teacher. Secondly, it differentiates the activity of teaching from such other activities as propaganda, conditioning, suggestion, and indoctrination, which are aimed at modifying the person but strive at all costs to avoid a genuine engagement of his judgment on underlying issues."[52]

In The Language of Education, Scheffler distinguishes what he calls the success use from the intentional use of

[50] Israel Scheffler, "Philosophical Models of Teaching", Harvard Educational Review, No. 35 (Spring 1965).

[51] I. Scheffler, The Language of Education. (Charles C. Thomas, Springfield, IL, 1960).

[52] I. Scheffler, "Philosophical Models of Teaching", p. 131.

'to teach'. "The success use refers to more than just doing something; it refers to the successful outcome of what one is doing. For example, "To have taught someone how to swim is more than to have been occupied in teaching someone to swim; it is also to have succeeded."[53] Scheffler provides the intentional use to account for those cases that we want to call cases of teaching where learning has not as yet occurred. For example, a case in which someone attends a series of classes to learn to swim, we want to be able to say that the teacher is engaged in teaching swimming, even though the student cannot as yet swim.

In this intentional use of 'to teach' Scheffler associates teaching with trying.[54] He states that "the goal of an activity may lie beyond the boundaries of the activity or some segment of it or may lack temporal conditions altogether, nevertheless engaging in the activity involves trying, generally.[55]

Scheffler, of course, recognizes that one may learn without being taught. In the success use, if the teacher is engaged in teaching, then the pupil is engaged in learning.

[53] I. Scheffler, The Language of Education, pp. 60-1.

[54] I. Scheffler, The Language of Education, p. 62.

[55] I. Scheffler, The Language of Education, p. 63.

Therefore, in the success use, teaching is a sufficient condition for learning and learning is a necessary condition for teaching. However, in the intentional use, if the teacher is engaged in teaching, then the pupil is not necessarily engaged in learning. In this sense, according to Scheffler, teaching involves an effort to achieve learning, but teaching is not a sufficient condition for learning, nor is learning a necessary condition for teaching. Scheffler then provides an intentional account of 'to teach'.

In providing such an account, he argues that "teaching involves trying as well as doing - trying to get someone to learn something."[56] Yet he is clearly not concerned to give a definition of 'learning'. He states that "what this learning consists in, how it may be exhibited are important but separate questions . . . irrelevant to our present purposes."[57] He also argues that attempts to provide such an account in extreme behavioristic terms; for example, in terms of rules of behaviors to follow; are misguided. Such behavioristic "rules of teaching may at best improve teaching in the sense of rendering it more effective; they cannot exhaustively rule out failure."[58] They rule out

[56] I. Scheffler, The Language of Education, p. 63

[57] I. Scheffler, The Lanugage of Education, p. 78.

[58] I. Scheffler, The Language of Education, p. 78.

neither failure to succeed in teaching (success use) nor failure to engage in teaching (intentional use).

Scheffler is also concerned to distinguish what he calls the intentional sense of 'to teach' from 'to propagandize', 'to condition', 'to suggest', and 'to indoctrinate', which may also be construed as somehow involving trying to get someone to learn something. He attempts to do so by requiring that the pupil, or the person that is the object of the teaching activity, "is not systematically prevented from asking the teacher 'how' or 'why' or 'on what grounds'."[59] He argues that in the other activities, one is systematically prevented from asking such questions and that, therefore, this requirement for the activity of teaching distinguishes teaching from these other intentional activities that also involve trying to get someone to learn something.

Scheffler argues that to see if someone is engaged in teaching (the intentional sense) "we must see if that someone is engaged in trying to get someone to learn something, but with appropriate qualifications."[60] Given Scheffler's brief characterization of teaching and his amplification and

[59] I. Scheffler, The Language of Education, p. 68.

[60] I. Scheffler, The Language of Education, p. 68.

clarification of the concept, we may formulate the following definition of 'teaching' in what Scheffler calls the intentional sense of 'to teach':

D.18 x is engaged in teaching y Ø iff x is engaged in trying to achieve the goal of initiating y's learning such that y is not systematically prevented from asking x 'how', 'why', or 'on what grounds'.

Intuitively, one wants to be able to say with a general definition of 'teaching' that one engaged in teaching is either engaged in teaching Ø and actually failing to teach Ø, or engaged in teaching Ø and actually succeeding in teaching Ø. In providing a definition of what he calls the intentional sense of 'teaching', Scheffler has attempted to capture the first of these intuitions. However, Scheffler has unclearly made a distinction between what he misleadingly calls the "intentional sense" and what he calls the "success sense" of teaching.

Teaching is a goal-oriented activity, according to Scheffler. From the fact that one does some action intentionally, it does not follow that one actually accomplishes the goal one had for doing the action. Nor does it follow from the fact that one does some action intentionally that one fails actually to accomplish the goal one had for doing the action. In this sense, then, teaching and actually failing to realize the goal of teaching, and teaching and actually succeeding in realizing the goal of teaching are both intentional activities. Teaching, as an intentional activity, allows for both actually failing and actually succeeding in realizing the goal. For this reason, it is misleading to distinguish an "intentional sense" from a "success sense" of teaching, since properly speaking, teaching is an intentional activity regardless of success or failure in attaining the goal of the activity. Therefore, I shall abandon Scheffler's terms for the distinction and simply distinguish the activity of engaging in teaching which fails to realize its goal, and the activity of engaging in teaching which succeeds in realizing its goal.

D.18 is an interesting definition in that it attempts to provide an account which takes seriously this intentional nature of teaching. However, D.18 fails adequately to account for the complexity of the intentional nature of teaching, and thereby fails to distinguish teaching from other actions. Consider the following counterexample. Suppose that another insane individual, whose mind has also been destroyed by drugs, is engaged in trying to achieve the goal of initiating her nurse's learning the basic principles of Marxist economics. They are seated across from one another at a table and the nurse is not systematically prevented from asking her 'how', 'why', or 'on what grounds'.

(In fact, this nurse has just completed a philosophy course in night school and is constantly asking everyone 'how', 'why', or 'on what grounds' in her own attempt to help her patients regain their reason.) Suppose that while trying to achieve this goal, this insane individual is moaning, drooling, and shaking her head at the ceiling while the nurse asks her 'how', 'why', or 'on what grounds'.

The problem here is failing to distinguish between engaging in teaching Marxist economics but failing to initiate the nurse's learning Marxist economics, and trying to engage in teaching Marxist economics but failing to engage in teaching. In this case, while we may grant that she is trying to engage in teaching Marxist economics, she has failed to engage in teaching. But, according to D.18, this insane individual is engaged in teaching her nurse the basic principles of Marxist economics, even though the nurse may fail to learn them. However, our intuitions tell us that she is merely engaged in moaning, drooling and shaking her head at the ceiling, and that she is not engaged in teaching, even though she may be engaged in trying to reach. Therefore, D.18 fails to capture the notion of engaging in teaching which fails to realize its goal.

It will not do to modify a definition like D.18 by simply adding that the trying be done successfully to capture the notion of engaging in teaching which succeeds in realizing its goal. Surely we must be able to distinguish successfully trying to teach from successful teaching; otherwise anything could be successfully taught simply by succeeding in trying to teach it.

We might modify D.18 in an attempt to provide a definition of 'teaching' which captures the notion of engaging in teaching which succeeds in realizing its goal as follows:

D.19 x is engaged in teaching y Ø iff x is engaged in achieving the goal of initiating y's learning Ø such that y is not systematically prevented from asking x 'how', 'why', or 'on what grounds' with respect to Ø.

Given D.19, one might expect to derive the notion of engaging in teaching which fails to realize its goal simply by inserting "or x is engaged in trying to achieve the goal of initiating y's learning Ø" and thereby defining 'teaching' such that one is able to say that one engaged in teaching is either engaged in teaching and failing to realize the goal of teaching, or engaged in teaching and succeeding in realizing the goal of teaching.

However, D.18 failed to capture the former sense of 'teaching' and D.19 fails to capture the latter sense of teaching. Consider the following counterexample. Suppose that a bright five-year-old girl is attending an advanced school, where on Tuesday she will successfully learn the Pythagorean theorem. Tuesday morning her mother walks her to school. As her mother drops her off at the door to her classroom, her mother asks her "Do you have any questions about geometry?", and the child answers "No, Mommy." In this case the mother engaged in successfully walking her child to school and is engaged in achieving the goal of initiating her daughter's learning the Pythagorean theorem. Certainly the child is not systematically prevented from asking her mother 'how', 'why', or 'on what grounds' with respect to the Pythagorean theorem since the mother asks her if she has any questions about geometry. Therefore, according to D.19, this mother is engaged in successfully teaching her child the Pythagorean theorem. However, the mother is engaged in successfully walking her child to school, not engaged in successfully teaching her child the Pythagroean theorem. Therefore, D.19 fails to capture the notion of engaging in teaching which succeeds in realizing its goal.

Both D.18 and D.19 have at least two other significant defects that it is useful to consider and avoid in attempting to provide a workable definition of 'teaching' for my purposes here. First, in both definitions, the term 'learning' is used in defining 'teaching'. Given such a definition of 'teaching' in terms of learning, to ask if critical intelligence can be taught is simply to ask if critical intelligence can be learned. Instead of providing a clear definition of 'teaching' in order decisively to answer the original question, such a definition merely trades the original obscure question for another equally obscure question. Therefore, for my purposes here, it is desirable to provide a definition of 'teaching' that avoids appeal to 'learning' as a primitive term. Secondly, given this desire to avoid 'learning' as a primitive term in a definition of 'teaching', one must distinguish among the kinds of activities preanalytically assumed to teaching activities.

Among the activities preanalytically assumed to be teaching activities, one may distinguish the activity of 'teaching how' from the activity of 'teaching that'. Given this distinction, a definition of engaging in teaching must allow for the activities of engaging in teaching how and failing to achieve learning, engaging in teaching that and failing to achieve learning, engaging in teaching how and succeeding in achieving learning, and engaging in teaching that and succeeding in achieving learning. By making the distinction between the activity of teaching how and the activity of teaching that, and by defining what it is to do each such that the definition allows for both failing to achieve learning and succeeding in achieving learning, one may, in turn, offer a clear and complete definition of 'teaching'.

Several philosophers have attempted to distinguish among the activities intuitively included as teaching activites. Many have distinguished teaching to, teaching to be, teaching when to, and teaching the difference between, as well as teaching how and teaching that.[61] However, these distinctions among activities intuitively thought to be teaching activities, upon analysis, reduce to either 'teaching that' or 'teaching how', or reduce to some other intentional activity like inculcating, conditioning, imploring, admonishing, etc., depending upon the situation. Consider the activity 'teaching to'. One may engage in teaching someone to sew, to swim, or to speak French. But it is difficult to see the philosophical difference between teaching someone to sew, or how to sew; to swim, or how to swim; to speak French, or how to speak French. It seems, therefore, that 'teaching to' is simply shorthand for 'teaching how to', and that, therefore, the teaching activity called 'teaching to' is simply the teaching activity called 'teaching how'.

Consider the activity of 'teaching to be'. Presumably one may be said to engage in teaching someone to be thrifty, to be patriotic, or to be honest. Yet our intuitions tell us

[61] See Gilbert Ryle, The Concept of Mind (NY: Barnes and Noble, 1949), and Israel Scheffler, The Language of Education.

that one may teach thrift, patriotism or honesty by advancing certain arguments, stating certain propositions, or stating certain rules to follow in order to be thrifty, to be patriotic, or to be honest. This may involve the activity of 'teaching that' or the activity of 'teaching how', yet one may successfully be taught certain arguments, propositions, and rules about thrift, patriotism, or honesty and still not be thrifty, patriotic, or honest. What has been called 'teaching to be' seems to involve other intentional activities which are not teaching activities. For example, one may inculcate, condition, implore or admonish someone to be thrifty, patriotic, or honest. Yet these activities are not teaching activities. Therefore, engaging in 'teaching to be' may be said to be teaching only insofar as it is engaged in 'teaching that' or 'teaching how'. It is not a distinct teaching activity; it involves other intentional activities that are not teaching activities.

Consider the activity of 'teaching when to'. Presumably one may be said to engage in teaching someone when to call a pass play, when to sacrifice a rook, or when to frost a cake. However, it is difficult to see that engaging in this activity differs from engaging in teaching someone how to call a football game, how to play defensive chess, or how to bake a cake. Therefore, the activity of 'teaching when to' simply reduces to the activity of 'teaching how'.

Consider the activity of 'teaching the difference between'. Presumably one may be said to engage in teaching someone the difference between the propositional calculus and the predicate calculus, the difference between truth and validity, or the difference between Hume's view and Kant's view of consciousness. However, it is difficult to see that engaging in this activity differs from engaging in teaching someone that the propositional calculus deals with the logic of propositions and that the predicate calculus deals with the logic of predicates and quantification; that truth is a property of propositions and that validity is a property of arguments; or that Hume's view can be understood with difficulty and that Kant's view cannot be understood. Therefore, the activity of 'teaching the difference between' simply reduces to the activity of 'teaching that'. Therefore, 'teaching that' and 'teaching how' exhaust the kinds of activities that are teaching activities. We must now consider the distinction of 'teaching that' and 'teaching how'.

Indeed, the basic question of the greatest importance to one attempting to provide a definition of 'teaching' is whether teaching that is ultimately distinguishable from teaching how. What is at stake in answering this basic question is the distinction commonly made between the requirements for teaching informtion and the requirements for teaching skills.

Teaching (that) information and correspondingly being taught (that) information is a relatively sudden occurrence. Teaching skills (how) and correspondingly being taught skills (how) is not a relatively sudden occurrence. For example, intuitively it makes sense to ask at what moment someone was taught that Lincoln was assassinated by Booth. However, it makes no sense to ask at what moment someone was taught how to perform open heart surgery. Teaching skills (how) seems to involve a longer term process, both on the part of the teacher and the one being taught, than teaching information (that). However, this alone certainly does not significantly distinguish the two. For example, consider teaching some complex information and some simple skill.

More significantly, teaching information (that) seems to engage the one being taught differently than the process of teaching skills (how). The one being taught information is concerned with knowing or believing that (to allow for being taught information that is false) while the one being taught a skill is concerned with knowing how (since skills are not the kind of things that can be false). Consider Gilbert Ryle's example of a boy who is taught that Sussex is a county in England and one who is taught how to play chess.

"The boy can be said to have a partial knowledge of the counties of England if he knows some of them and does not know others. But he could not be said to have an

> (partial) incomplete knowledge of Sussex being an English county. Either he knows this fact or he does not know it. On the other hand, it is proper and normal to speak of a person knowing in part how to do something, i.e., of having a particular capacity in a limited degree. An ordinary chess player knows the game pretty well, but a champion knows it better, and even the champion still has much to learn."[62]

In being taught that Sussex is an English county, the boy is participating in the relationship of knowing or believing between himself and the proposition. In being taught how to play chess, one is participating in the relationship of knowing between oneself and such skills. Knowing how and knowing or believing that are distinct since knowing how admits of degrees in a way that knowing or believing that does not admit of degrees.

Similarly, one engaged in teaching the boy that Sussex is an English county is concerned with applying methods that will most likely insure that the boy is successfully taught that Sussex is an English county. These methods will ultimately depend for their success upon their success in establishing the relationship of knowing or believing between pupils and such propositions. In this way, teaching that involves knowing that or believing that.

[62] Gilbert Ryle, The Concept of Mind, (NY: Barnes and Noble, 1949) p. 59.

One engaged in teaching the boy how to play chess is concerned with applying methods that will most likely insure that the boy is successfully taught how to play chess. These methods will ultimately depend for their success upon their success in establishing the relationship of knowing between pupils and such skills. In this way, teaching how involves knowing how.

Teaching that and being taught that, therefore, involves knowing that or believing that, since one may be taught propositions that are false. Teaching how and being taught how, therefore, involves knowing how, since these skills are not the kinds of things that can be false. One may, of course, teach someone how to play chess incorrectly, but that involves teaching some skill other than chess. The process still involves knowing how, although the one being taught may still not know how to play chess, but know how to engage in some other activity.

The distinction between the activity of teaching that and the activity of teaching how is, therefore, based upon the distinct requirements of knowing that or believing that for teaching and being taught that, and knowing how for teaching and being taught how. However, many philosophers have argued that knowing that is not distinct from knowing how.[63] If knowing that simply reduces to knowing how, and they are not distinct, then these are not dinstinct requirements upon which to base the distinction between teaching that and teaching how. Before adopting this distinction for a definition of 'teaching', we must first consider the arguments purporting to show that knowing that and knowing how are indistinct.

The most common argument offered to support the claim that knowing that is indistinct from knowing how is the argument attempting to show that knowing that simply reduces to knowing how.[64] John Hartland-Swann argues that in Ryle's example, the boy's knowing that Sussex is an English county is simply a version of his knowing correctly how to reply to a question.[65] He argues that:

[63] John Hartland-Swann, "The Logical Status of Knowing That," Analysis (1956), Kenneth Conklin, "Knowledge, Proof, and Ineffability in Teaching," Education Theory (1974). See also Jane Roland Martin, "On the Reduction of 'Knowing That' to 'Knowing How'," Language and Concepts in Education, edited by B. O. Smith and R. H. Ennis (NY: Random House, 1961).

[64] John Hartland-Swann offers such an argument, and his is taken by many to be the most influential for the field of education.

[65] John Hartland-Swann, "The Logical Status of 'Knowing That'," Analysis (1956). He also considers whether knowing is a dispositional or an episodic verb. He argues that it is dispositional, and that since Ryle also argues that it is dispositional, Ryle ought to give up the distinction between knowing how and knowing that. The nature of Ryle's view of knowing and Hartland-Swann's arguments with Ryle on this issue are not within the scope of present interest.

"'Either he knows this fact or he does not know it' must surely be translated 'either he is able (knows how) to give the correct answer, or he is not able (does not know how) to give the correct answer'."[66]

Given this means of translating 'knowing that' statements into 'knowing how' statements, in being taught that Sussex is an English county, the boy is participating in the relationship of knowing between himself and the skill of giving the correct answer to a question, not between himself and some proposition. Similarly, one engaged in teaching the boy that Sussex is an English county is concerned with applying methods to insure that the boy successfully gives the correct answer to the question "Is Sussex an English county?," not to insure the establishment of the relationship of knowing between the boy and the proposition.

If Hartland-Swann's translation is correct, a distinction between teaching how and teaching that based on a distinction between knowing how and knowing that is useless for the attempt to provide a clear definition of 'teaching'. The usual distinction between the requirements for teaching information and the requirements for teaching skills simply collapses. Hartland-Swann concludes that:

[66] John Hartland-Swann, "The Logical Status of 'Knowing That'," Analysis, (1956) p. 113.

> "All cases of knowing that can and, indeed, must (if 'know' is a capacity verb and therefore dispositional) be reduced ultimately to cases of knowing how. Ryle however, wishes to insist on a non-parallelism. But these non-parallelisms, though defensible by an appeal to ordinary linquistic usage . . . break down after . . . philosophical analysis."[67]

Hartland-Swann's attempts and similar attempts to reduce knowing that to knowing how are, however, unsuccessful. Hartland-Swann adopts a dispositional view of knowing in an attempt to explain all knowing exclusively in terms of dispositions to behave. According to Hartland-Swann, the disposition to behave involved in every case of knowing that is the disposition to "state correctly what is the case." However, this reduction of 'knowing that' to 'knowing how' produces an indefensible account of 'knowing that'.[68]

Hartland-Swann argues that someone who knows that P would be disposed to state that P when asked. Thus, his dispositional account of knowing that involves a counterfactual. This can

[67] John Hartland-Swann, "The Logical Status of 'Knowing That'," Analysis, (1956) p. 114.

[68] This has been argued by others, including Robert Ammerman, "A Note on 'Knowing That'," Analysis, (Dec. 1956), p. 30-2. Ammerman attacks the unclarity of 'correctly', and argues that the reduction is "either inadequate to the essential features of knowing that, or circular." (p. 32). His arguments are weak or no good at all.

be seen by presenting the following definition of 'knowing that' on Hartland-Swann's behalf:

K.1 x knows that P iff if x were asked, then x would be able to state correctly that P (where P is a true proposition).

Intuitively, knowing, believing, as well as thinking have a certain dispositional character, part of which may be captured by such counterfactual conditionals.[69] However, K.1 clearly does not provide a sufficient condition for knowing that P, and, therefore, fails as a definition designed to reduce knowing that to knowing how.

Suppose that some authority tells x that Paris is the capital of France. Suppose that x mildly distrusts this authority, yet x has no other inclinations concerning the proposition expressed by the statement "Paris is the capital of France," and when asked, x would answer that Paris is the capital of France since x has no other available response on the topic. Since the definiens is a counterfactual, it does not require specific behavior, but simply requries a specific disposition

[69] Again, I shall ignore the problem of providing truth conditions for such counterfactuals and consider the matter on an intuitive level. Certainly to grant that knowing, believing, and thinking have a dispositional character is not to grant that they may be given an adequate account simply in dispositional terms.

to behave: being able to state correctly that Paris is the capital of France. Suppose that we attempt to determine, according to K.1, that x knows that Paris is the capital of France. Clearly, if x were asked, then x would be able to state correctly that Paris is the capital of France. Therefore, according to K.1, x knows that Paris is the capital of France. However, in this case, x cannot properly be said to know that Paris is the capital of France; x has no evidence to justify the statement, only the unsupported testimony of a mildly distrusted authority. Therefore, K.1 fails to provide a sufficient condition for knowing that.

One problem, therefore, with K.1 seems to be that nothing in the definition requires the justification of the statement P. Intuitively, some sort of judgment of justification is required to support a claim that x knows that P. However, we may not attempt to repair this difficulty with K.1 on Hartland-Swann's behalf by any appeal to some mental activity such as judging a proposed justification, since he is attempting to show that we may dispense with such appeals to mental activities in favor of a purely dispositional account. Therefore, we may repair this defect only at the expense of Hartland-Swann's proposed reduction. Nor will it help to attempt to repair K.1 by eliminating the counter-factual in favor of a material conditional; then x knows that

P whenever x is not asked, since a material conditional is true whenever the antecedent is false.

Therefore, Hartland-Swann has not shown that knowing that and knowing how are indistinct. It seems, then, that the intuitive distinction between knowing that (information) and knowing how (skills) holds against such arguments, and that our intuitions may be reflected in distinct requirements for each. Therefore, the distinction between the activities of teaching that or being taught that and the activity of teaching how or being taught how, based upon the distinct requirements of knowing or believing that and knowing how, is not affected by Hartland-Swann's arguments.

From examining D.18, we saw that an adequate definition of teaching must include both the activities of engaging in teaching which fails to realize its goal, and engaging in teaching which succeeds in realizing its goal. We must now attempt to provide a definition of 'teaching that' in terms of knowing or believing that, such that it captures both failing to and succeeding in realizing its goal. We must then attempt to provide a definition of 'teaching how' in terms of knowing how, such that it captures both failing to and succeeding in realizing its goal. We will then be in a position to combine these definitions and to define 'teaching' in terms of these definitions of 'teaching that' and 'teaching how'. Therefore, consider the following definition of 'teaching that', based on believing that:

D.20 x is engaged in teaching y Ø at t iff:

(1) y does not believe that Ø at t-1 or x does not believe that y does believe that Ø at t-1, and

(2) x is trying to bring it about that y believes that Ø at t+1, or if x is acting in place of z, then x's activity, designated by z to bring it about that y believes that Ø at t+1, involves what z believes to be z's justification for believing Ø, and

(3) y comes to believe that x believes that Ø at t, and

(4) y comes to believe that x believes that x is justified in believing that Ø at t, or

(5) y does not believe that Ø at t-1, or x does not believe that y does believe that Ø at t-1, and

(6) x is trying to bring it about that y believes that Ø at t+1, or if x is acting in place of z, then x's activity, designed by z to bring it about that y believes that Ø at t+1, involves what z believes to be z's justification for believing Ø, and

(7) y comes to believe that x believes that Ø at t and y comes to believe that Ø at t+1, and

(8) y comes to believe that x believes that x is justified in believing that Ø at t and y comes to believe that y is justified in believing that Ø at t+1.

D.20 defines 'teaching that' as an intentional activity. Therefore, D.20 rules out teaching machines as engaging in teaching that, since teaching machines are not the kinds of things that have intentions, goals, or beliefs. One might argue that teaching machines might more properly be called 'learning machines', since learning may occur without teaching. D.20 also avoids using 'learning' as a primitive term, and thereby avoids the charge of defining an unclear educational activity in terms of an equally unclear educational activity.

The definiens of D.20 is a disjunction. The first disjunct captures the activity of engaging in teaching that, which may fail to realize its goal, while the second disjunct captures the activity of engaging in teaching that which succeeds in realizing its goal. In both senses of teaching that, our definition must allow for the possibility of teaching something that is false. Therefore, we need to use the weaker belief requirement rather than the stronger knowledge requirement in both disjuncts. D.20, therefore, allows that x may both teach and fail or teach and succeed in teaching something that either x believes to be false, or that x believes to be true but is, in fact, false.

The definition also allows that x may teach and fail, or teach and succeed in teaching y something that y may already believe. The case of failing is clear. The case of succeeding requires that y come to believe that y is justified in the belief. The definition also allows for the following kind of case.[70] Suppose that Miss Lowell of Smith designs an intermediate logic course for early morning educational television. However, the producer realizes that she is far too ugly to appear on television. She, therefore, hires Mr. Forrester, a non-method actor, who dresses like a teacher, and who memorizes Miss Lowell's lines. We tune in the T.V. and ask "What is Mr. Forrester doing?" and reply "He is teaching the axiom of choice." However, Mr. Forrester is an ignorant slob who reads comics, and cannot understand a word he has memorized. D.20 allows us to say that Mr. Forrester is engaged in teaching that, in either sense that fits a particular situation, since Mr. Forrester is acting in place of Miss Lowell and his activity, designed to bring it about that someone in the audience believes that Ø at t+1, involves what Miss Lowell believes to be her justification for believing Ø (provided, of course, that the other conjuncts of the relevant disjunct of D.20 are satisfied). If, for example, an actor colleague of Forrester's (y) tunes in the program, knows Forrester is an actor and an ignorant slob who cannot understand a word he has memorized and, therefore, does not believe that

[70] This is a proposed counterexample to Scheffler's account of what he misleadingly calls the intentional sense of 'to teach' proposed by James McClellan, "A Review of Scheffler's Language of Education," Journal of Philosophy, No. 58 (1961), p. 415-20.

Forrester believes the axiom of choice, then conditions (3) and (4) or conditions (7) and (8) are violated. In this case, Forrester cannot be said to be engaged in teaching his actor colleague according to D.20. He may simply be said to be engaged in acting. Therefore, D.20 is also designed to legislate cases for which our intuitions may be uncertain.

D.20 also allows one to distinguish both senses of teaching that from other intentional activities. Consider the case of a CIA agent torturing a prisoner, thereby intending to convince him that he should cooperate. D.20 does not specify how y comes to believe anything, so D.20 may at first be thought to allow torturing to be teaching. However, there are problems with this case. The first problem is that 'that he should cooperate' is not straightforwardly a proposition, but rather seems to have the character of an imperative, or a moral principle,[71] unlike 'that Columbus discovered America'. Therefore, according to D.20, torturing may not be a case of 'teaching that' at all, but a case of what has been called 'teaching to'; the agent is simply thought to be engaged in teaching the prisoner to cooperate. However, I have argued that 'teaching to' is

[71] As such it may be true or false or it may not. Either case requires some argument. The point, however, is that the issue needs to be addressed in this case.

neither 'teaching that' nor 'teaching how'. In fact, the way 'teaching to' is used, it is not 'teaching' at all. For example, one may teach someone either how to be thrifty, or that thrift is economically useful; one may successfully teach either without having the one taught be thrifty. Teaching someone to be thrifty is not teaching, but involves indoctrinating, conditioning, and other activities.[72] Therefore, if 'that he should cooperate' really means 'to cooperate', the case is not applicable to D.20, and D.20 allows us to distinguish teaching that from activities like torturing, indoctrinating, and conditioning.

Suppose that we modify this torturing case slightly to accommodate this problem. Suppose that the CIA agent is torturing a prisoner, attempting to convince him of the truth of the proposition that 'cooperation with the CIA is politically useful'. There have been studies on the effects of torture on individual beliefs, but the problem with this case involves (4), (7) and (8). Consider the first disjunct of D.20. Such a case of torture may satisfy (1) and (2) and (3) of D.20, but such a case does not unproblematically satisfy (4). It is not clear that torturing is the

[72] As John P. Powell points out in "Philosophical Models of Teaching," Harvard Educational Review, Vol. 35, (1965), p. 494-96, indoctrination and conditioning certainly have their place in education. My point, however, is that they are distinguishable from teaching.

kind of activity which may be said genuinely to affect the prisoner's belief about the agent's justification for his belief. The prisoner may outwardly assent to (4) under torture, but it is doubtful he could be said to believe that the agent believes that he is justified in this belief. In fact, he may believe that the agent believes he is unjustified in his belief, but believes that the agent simply enjoys torturing prisoners. Torture is not the type of activity that promotes confidence in, or gives much insight into justification. Therefore, the notion of justification in (4) serves to distinguish teaching that from torturing.

Consider the second disjunct of D.20; such a case of torture may satisfy (5) and (6), but such a case does not unproblematically satisfy (7) and (8). Again, it is not clear that torturing is the kind of activity which may be said to genuinely affect the prisoner's beliefs. He may come to believe that he had better say that he believes that cooperation with the CIA is politically useful (to save himself from pain) and yet still not believe 'that cooperation with the CIA is politically useful'. Again, torturing is not the type of activity that promotes confidence in, or gives much insight into justification. The prisoner may, in fact, come to believe that he is justified in believing that he had better say that he believes that cooperation with the CIA is politically useful, but this certainly does not satisfy D.20 (8). Therefore, D.20 successfully distinguishes teaching that from activities like torturing.

One may object to D.20 on the grounds that it fails to distinguish teaching from telling. However, this is not a serious objection. Again, D.20 is designed to legislate such cases for which our intuition may be unclear. Suppose that x comes up to y and says "your house is on fire." Clearly this can be made to satisfy either disjunct of D.20, and, therefore, according to D.20, x is engaged in teaching y that y's house is on fire. It is claimed that this is extremely odd, and that really x is simply engaged in telling y that y's house is on fire, not engaged in teaching y that y's house is on fire.

This claim depends on assuming that telling is not teaching that, and this assumption seems to depend on a certain view from ordinary language. We ordinarily say that, in such a case, when asked what x is doing, that x is engaged in telling y that y's house is on fire. However, what is of interest here is not what ordinary linguistic practice licenses, but rather what distinction, if any, is to be made between the necessary and sufficient conditions for engaging in these activities. In defense of D.20, we can claim that the activity of teaching that is the activity of telling that, since they have the same necessary and sufficient conditions.

This is not very surprising. For example, when Moses descended from Mount Sinai with the Ten Commandments, he was said to be engaged in teaching the Israelites that the First Commandment is "Thou shalt have no other Gods before me," and so on through the Ten Commandments. However, suppose that there was only one Commandment, namely the First. We might imagine in this case that Moses was said to be engaged in telling the Israelites that The Commandment is "Thou shalt have no other Gods before me." The point is, however, that in either case the same necessary and sufficient conditions must be satisfied in terms of Moses doing the teaching that, or telling that, and the Israelites being taught that, or being told that. The distinction between teaching that and telling that seems to be based on linguistic practice and not on any conceptual differences between the activities.[73] Therefore, that D.20

[73] It may strike native speakers of English oddly to state that x is engaged in teaching y a proposition that is specific such as 'that y's house is on fire' but it may not strike the same native speaker oddly to state that x is engaged in teaching y a proposition that is general, such as 'that houses burn'. Of course, these feelings may vary given different specific and general propositions. However, the point to be made here is that this is simply a matter of linguistic convention.

fails to distinguish teaching that and telling that is not a serious objection to D.20; the activity is the same.

Consider the following definiton of 'teaching how' based on knowing how:

D.21 x is engaged in teaching y how to Ø at t iff

(1) x believes at t that y does not know how to Ø at t-1, and

(2) x is trying to bring it about that y does know how to Ø at t+1, or if x is acting in place of z, then x's activity is designed by z to bring it about that y does know how to Ø at t+1, and

(3) y does not know how to Ø at t-1 and if x does not engage in providing a model between t-1 and t+1 for y to Ø, then y does not know how to Ø at t+1, or

x does not believe that y does know how to Ø at t-1 and x engages in providing a model between t-1 and t+1 for y to Ø,

where x provides a model for y to Ø iff x intends, or some z intends that x make evident the applications of the rules according to which someone can do Ø, or

(4) x believes at t that y does not know how to Ø at t-1, and

(5) x is trying to bring it about that y does know how to Ø at t+1, or if x is acting in place of z, then x's activity is designed by z to bring it about that y does know how to Ø at t+1, and

(6) y does not know how to Ø at t-1 and if x does not engage in providing a model between t-1 and t+1 for y to Ø, then y does not know how to Ø at t+1, and

(7) x does engage in providing a model between t-1 and t+1 for y to Ø, and

(8) y does know how to Ø at t+1, evidenced by y doing Ø at t+1, where x provides a model for y to Ø iff x intends, or some z intends that x make evident the applications of the rules according to which someone can do Ø.

D.21 defines 'teaching how' as an intentional activity. Therefore, D.21 also rules out teaching machines as engaging in teaching how, since teaching machines are not the kinds of things that can know or believe. D.21, like D.20, avoids using 'learning' as a primitive term and thereby avoids the charge of defining an unclear educational activity in terms of an equally unclear educational activity.

The definiens of D.21 is a disjunction. The first disjunct captures teaching how and failing to realize the goal of teaching, while the second disjunct captures teaching how and succeeding in realizing the goal of teaching. D.21 also allows for trying to teach someone how to do something he already knows how to do. It also handles counterexamples like the aforementioned case of the actor, Mr. Forrester, teaching someone how to do a proof in a first order natural deduction system. D.21 allows us to say that Mr. Forrester is engaged in teaching how, in either sense that fits a particular situation, since Mr. Forrester is acting in place of Miss Lowell and his activity is designed by Miss Lowell to bring it about that someone does know how to do a proof in a first order natural deduction system. Suppose, again, that an actor colleague of Forrester's tunes in the program, knows Forrester is an actor and an ignorant slob who cannot understand a word he has memorized. D.21 allows for the possibility that y does not know how to do a proof in a first order natural deduction system and that Forrester may provide a model for y to do such a proof, since Miss Lowell and the producer intend that Forrester make evident the applications of the rules according to which someone can do such a proof, whether Forrester understands what he has memorized or not. In this way D.21 allows for the possibility that Forrester may engage in teaching how, in either sense that fits a particular situation. Therefore, D.21 is also designed to legislate cases for which our intuitions are unclear.

D.21 also allows one to distinguish teaching how from other activities. Suppose that a psychologist is concerned to treat a patient who cannot regulate his eating habits. The psychologist sets up a system of rewards for proper eating habits and punishments for improper eating habits, designed to reinforce proper eating habits, and to cause the patient to learn how to regulate his eating habits. Our intentions tell us that in this case, the psychologist is not engaged in teaching the patient how to regulate his eating habits, but instead is engaged in some other intentional activity, namely conditioning the patient to regulate his eating habits. This intuition is born out by D.21.

Consider the first disjunct of D.21. This case may satisfy (1) and (2), but it does not satisfy (3). The psychologist is not engaged in providing a model for the patient to regulate his eating habits; the psychologist does not simply intend to make evident the applications of the rules according to which someone can regulate his eating habits. In this case, the patient may already know how to regulate his eating habits, but simply lacks the will to, in fact, do so. The psychologist is attempting to address the latter problem, rather than the former. One may conceive a case in which the psychologist may engage in intending to teach a patient how to regulate his eating habits, but D.21 allows us to distinguish such a case from the case of engaging in some other intentional activity like conditioning.

Consider the second disjunct of D.21. This case may also satisfy (4) and (5), but it does not satisfy (6). Again, it fails to satisfy (6) since the psychologist cannot be said to be engaging simply in providing a model for the patient to regulate his eating habits. When the psychologist is so engaged, he can be said to be engaged in teaching the patient how to regulate his eating habits, provided the other conditions are satisfied. When the psychologist is not so engaged, he cannot be said to be engaged in teaching how, but rather is engaged in some other intentional activity. In this way, D.21 allows us to distinguish the activity of teaching how from other intentional activities.

We are now in a position to provide a definition of 'teaching'. I have argued that 'teaching that' and 'teaching how' exhaust the kinds of activities that we may call teaching activities,[74] and that each activity has two senses; a sense in which the teaching fails to realize its goal, and a sense in which the teaching succeeds in realizing its goal. We now have definitions of these activities; D.20 for 'teaching that' and D.21 for 'teaching how'. Given D.20 and D.21, consider the following definition of 'teaching':

D.22 x is engaged in teaching y Ø at t iff

(1) x is engaged in teaching y and Ø at t (D.20), or

(2) x is engaged in teaching y how to Ø at t (D.21)

D.22 provides a definition of 'teaching' which will legislate difficult cases in order to distinguish teaching

[74] I have argued that the activities preanalytically thought to be teaching activities either reduce to teaching how or teaching that, or are, in fact, other intentional activities.

from other intentional activities. D.22 provides, on the basis of D.20 and D.21, an account of teaching in answer to the question "What is teaching?"

With the notion of teaching clarified in answer to question 2 by D.22, we are now in a position to determine if or to what extent critical intelligence as defined by D.12 in Chapter One can be taught, and answer question 3, "Can critical intelligence be taught?"

CHAPTER III

CAN CRITICAL INTELLIGENCE BE TAUGHT?

To ask if critical intelligence can be taught is, according to D.12, to ask if correct critical thinking can be taught. Attempted answers to the question "Can critical thinking be taught?" may, for convenience, be divided into two groups. Philosophers and educational psychologists in the first group have directly addressed the question "Can critical thinking be taught?"[75] Their discussions involve both an appeal to some notion of critical thinking as well as some view of teaching. Rather than consider each attempted answer in this first group, I shall critically consider one representative attempt.

Philosophers in the second group have indirectly addressed this question by addressing the question "Can virtue be taught?"[76] Their discussions involve an attempt to provide an answer to this question by appealing to some view of teaching and some view of the relation of teaching and

[75] Thomas G. Devine, "Can We Teach Critical Thinking?," Elementary English (1964). Edmund L. Pincoffs, "What Can be Taught?," Monist, No. 52 (Jan. 1968), pp. 120-132. I shall consider Devine's argument.

[76] I shall consider the question as raised by Plato in the Meno and the answer as provided by Israel Scheffler in The Language of Education. The bibliography on 'virtue' is enormous.

learning. Rather than consider each attempted answer in this second group, I shall critically consider one representative attempt and its importance for answering the question "Can critical thinking be taught?" I shall then provide my own detailed discussion by applying the definition of 'critical intelligence', D.12, the definition of 'teaching' from Chapter II, thereby directly answering the question "Can critical intelligence be taught?"

Direct Answer to the Question: Group One

Thomas G. Devine directly answers the question "Can critical intelligence be taught?" by directly answering the question "Can critical thinking be taught?" His answer is no; according to Devine, critical thinking cannot be taught. He claims that:

> "We cannot teach critical thinking as such. No matter how noble our intentions, or how grandly we phrase our objectives, the unpleasant truth remains: we cannot teach critical thinking as a process in itself. We can teach about critical thinking. We can select abilities which seem to be associated with critical thinking and we can discuss these abilities with our pupils. But we cannot teach these abilities as such."[77]

[77] Thomas G. Devine, "Can We Teach Critical Thinking?," Elementary English, No. 41 (Feb. 1964), pp. 154-55.

To support this claim that one cannot teach critical thinking abilities, Devine offers two arguments. First, Devine argues that critical thinking abilities cannot be taught because critical thinking abilities are what he calls "only postulated mental constructs." He argues that:

> "The abilities which we believe to be involved in the critical thinking process (such as recognizing inferences, recognizing assumptions, distinguishing relevant from irrelevant evidence, etc.) are "mental constructs." We can only postulate their existence. We cannot promote growth in these abilities. We cannot measure to discover whether or not growth has taken place. The best we can say, in our present state of knowledge, is that critical thinking seems to be a composite of as many as forty separate abilities, and that these abilities, so far, remain postulates or mental constructs."[78]

Devine's first argument seems to be that specific critical thinking abilities such as the ability to perform deductive operations according to the rules of some deductive logical system that is both consistent and truth preserving, or to perform inductive operations according to some rules of inductive support to degree n ((1) from D.11) is a "mental construct" the existence of which is "postulated." It seems that in Devine's argument, abilities that are "postulated mental constructs" are by definition artificial abstract entities that cannot be developed, affected,

[78] Thomas C. Devine, "Can We Teach Critical Thinking," p. 155.

and measured for growth by any educational or psychological means since, as artificial abstract entities, they are detached from persons, or at least unavailable to outside observers. It, of course, follows from this definition that the ability to perform deductive operations according to the rules of some deductive logical system that is both consistent and truth preserving, or to perform inductive operations according to some rules of inductive support, is an ability that cannot be developed, affected and measured for growth by any educational or psychological means since, as a critical thinking ability, it is also a postulated mental construct.

Devine's first argument can be represented as a deductively valid argument of the form all A is B; all B is C; therefore, all A is C.

1. All specific critical thinking abilities are postulated mental constructs.
2. All postulated mental constructs are incapable of being developed, affected, and measured for growth.

∴ 3. All specific critical thinking abilities are incapable of being developed, affected and measured for growth.

However, Devine's first argument is unsound. There are no reasons offered to support either premise 1 or premise 2.

Assuming that premise 2 is true,[79] premise 1 depends on some view of critical thinking as an individual activity that occurs unobserved by others and that therefore, others may only postulate critical thinking abilities in an individual. This view of critical thinking, however, is mistaken.

Consider the ability to perform deductive operations according to the rules of some deductive logical system that is both consistent and truth preserving, or to perform inductive operations according to some rules of inductive support (from D.11) as a critical thinking ability. Suppose x is engaged in judging whether a statement does or does not follow deductively from a presented statement or set of statements, or does not follow inductively or deductively from any presented statement or set of statements (from D.10). We cannot observe x making this judgment insofar as we cannot observe another's mental events but suppose we suspect that x is simply guessing and has no such critical thinking ability. We therefore ask x to justify the judgment. If x replies, "I guessed," then our suspicions are confirmed. If, however, x produces an appeal to inductive or deductive rules of inference to support the

[79] The notion is very unclear. This unclarity necessitates lengthy reconstructions of the notion which would unnecessarily complicate and lengthen the argument. Therefore, I shall simply assume, for the purpose of the argument, that premise 2 is true.

judgment, then in this case (according to D.10) we must say that x is engaged in critical thinking. It seems possible, then, to measure at least the presence or absence of this specific ability to engage in critical thinking. If we may at least measure the presence or absence of this specific critical thinking ability, then we may measure x at t and again at t+1 to determine if this ability is absent at t and present at t+1. In this way we may begin to measure its growth. If all postulated mental constructs are incapable of being developed, affected, and measured for growth, then premise 1 is unsound; not all specific critical thinking abilities are what Devine calls postulated mental constructs. Therefore, Devine's first argument does not support the conclusion that all specific critical thinking abilities are incapable of being developed, affected and measured for growth. Critical thinking abilities are not postulated mental constructs.[80] The first argument, therefore, is inconclusive for the purpose of determining if critical thinking can be taught.

Secondly, Devine argues that critical thinking abilities cannot be taught because one only observes these abilities in what Devine calls "language contexts." He argues that:

[80] Again, I shall ignore the issue of whether postulated mental constructs can or cannot be developed, affected and measured for growth because the notion is hopelessly unclear.

> "We can see these abilities at work only in some language context. We can only postulate the existence of critical thinking abilities but we can teach and measure a corresponding critical reading or critical listening ability. For example, the ability to recognize an inference is a mental construct, but the ability to recognize a writer's inferences is a critical reading ability we can teach."[81]

Again, this argument depends on the view that specific critical thinking abilities are what he calls 'postulated mental constructs'. Indeed the problem with his second argument as well as the problem with his first argument, is a hopelessly inadequate view of the nature of critical thinking abilities and a hopelessly inadequate account of what it is to engage in critical thinking.

Devine seems to argue that the only educationally meaningful account of critical thinking abilities and the only educationally meaningful account of engaging in critical thinking must be given in terms of some other abilities which are not themselves critical thinking abilities. In Devine's view, after all, critical thinking abilities are mental constructs. Indeed, he claims that "the language arts teacher can best translate critical thinking abilities into operational terms."[82] This presumably involves

[81] T. G. Devine, "Can We Teach Critical Thinking?," <u>Elementary English</u>, (1964) p. 155.

[82] T. G. Devine, "Can We Teach Critical Thinking?," p. 155.

translating what he calls "the ability to recognize an inference," which in his account is a postulated mental construct, into what he calls "the ability to recognize a writer's inferences," which in his account he calls a critical reading ability.

However, as I have argued, critical thinking abilities are not what he calls 'postulated mental constructs'. Devine provides no further arguments to support his claim that critical thinking abilities cannot be taught. Both his arguments depend upon the claim that critical thinking abilities are postulated mental constructs, and cannot be taught because postulated mental constructs cannot be taught. He offers no reasons to distinguish what he calls critical reading abilities, which he grants can be taught, from critical thinking abilities, which he claims cannot be taught, other than his definition of critical thinking abilities as postulated mental constructs. Therefore, Devine fails to show that critical thinking abilities cannot be taught. He therefore fails to provide a determinative answer to the question "Can critical thinking be taught?"

The general problem with Devine's attempt and similar attempts directly to answer the question "Can critical thinking be taught?" is the lack of a clear definition of what it is to engage in critical thinking, and what it is to have the ability to engage correctly in critical thinking. In Chapter I, I have provided both a definition of what it is to have the ability to engage correctly in critical thinking (D.10) and a definition of what it is to have the ability to engage correctly in critical thinking(D.11) as a first step toward directly answering this question. However, we have seen that an account of teaching is also important for providing an answer to this question. We may, therefore, first consider a distinction between two success senses of 'teaching' which may be construed as providing an indirect answer to this question "Can critical thinking be taught?"

Indirect Answer to the Question: Group Two

In the Meno,[83] Plato raises the question "Is virtue teachable?" At 86d, Socrates asks "Is virtue teachable, or do men have it as a gift of nature?" This question and attempted answers to it resemble the question "Is critical intelligence teachable?" and answers to it. Both questions raise similar prior questions; the prior question "What is virtue?", compared with the prior question "What is critical intelligence?"; and both raise the question "What is successful teaching?" The latter prior question is the

[83] The Collected Dialogues of Plato (Huntington Carrens, Edith Hamilton, ed., NY: Random House, 1961).

point of interest in the discussion of the question "Can virtue be taught?" for the discussion of the question "Can critical thinking be taught?" We may, therefore, consider a proposed answer to the latter prior question in the discussion of the question "Can virtue be taught?" and hope to apply this proposed answer to a discussion of the question "Can critical thinking be taught?"

Socrates asks at 87b "What attribute of the soul must virtue be if it is to be teachable, or otherwise?" He then rhetorically asks ". . . in the first place, if it is anything else but knowledge, is there a possibility of anyone teaching it . . .?" At 37e he says "Suppose that virtue is a kind of knowledge. If it is, then it will be teachable; otherwise it will not."

Israel Scheffler claims that Socrates argues that no one willingly and knowingly chooses to do evil or to reject virtue.[84] Scheffler states that, according to Socrates,

> "If someone knows what the good is, he cannot fail to choose it. Thus virtue can be taught. We need merely to succeed in teaching people to know what is good, and virtue is guaranteed. In contradiction to this view, most philosophers have held that men frequently

[84] Israel Scheffler, The Language of Education, pp. 84-85.

> do reject what they believe to be good and knowingly choose evil . . . that knowledge is not sufficient for virtue . . . that right will is also required."[85]

Scheffler points out that Socrates' view that virtue is knowledge and his claim that one who knows virtue will be virtuous in action generates a disagreement over the meaning of 'successfully teaching' virtue, and he argues that this is not, in fact, a disagreement over whether or not virtue can be taught. Given that virtue is knowledge, Socrates argues that virtue is successfully taught iff the pupil is virtuous in action, while other philosophers have agreed that virtue (being knowledge) is successfully taught iff the pupil knows virtue, but that this knowledge is in no way a sufficient condition for being virtuous in action. It appears that defenders of the latter position disagree with defenders of the former position over whether or not virtue can be successfully taught.

However, Scheffler attempts to offer an account of this disagreement over whether or not virtue can be taught by arguing that what is at stake is really a disagreement over the meaning of 'successfully teaching' virtue. To do so, Scheffler provides a distinction between what he calls "successfully teaching in an active sense" and "successfully

[85] Israel Scheffler, The Language of Education, p. 85.

teaching in a non-active sense." If this distinction helps clarify and resolve this disagreement over whether or not virtue can be taught, perhaps such a distinction will help in an attempt to answer the question "Can critical intelligence be taught?," since we might anticipate the same kind of disagreement in a discussion of this question.

If we view critical intelligence in terms of specific critical thinking abilities, then critical intelligence can be viewed as knowledge. Given that critical intelligence is knowledge, one may either argue (paralleling Socrates) that critical intelligence is successfully taught iff the pupil is critically intelligent in action, or argue (paralleling other philosophers) that critical intelligence is successfully taught iff the pupil knows critical intelligence, but that this knowledge is in no way a sufficient condition for being critically intelligent in action. Thus, we appear to have a disagreement over whether or not critical intelligence can be successfully taught much like the disagreement over whether or not virtue can be successfully taught. If Scheffler can show that such a disagreement simply reduces to applying equivocal senses of 'successfully teaching', then we will be in a clearer position to answer the question and to resolve the disagreement.

In an attempt to clarify and resolve this disagreement and to show that the disagreement really involves equivocal senses of 'successfully teaching', Scheffler argues that the success sense of 'teaching' can be given what he calls an active interpretation. This, according to Scheffler, means (for the question "Can virtue be taught?") that if the teaching is successful, then the pupil, in fact, acquires virtue in his conduct. In the active interpretation, the behavioral aquisition of virtue is automatically insured by the success in teaching it. However, the success sense of 'teaching' can also be given what he calls a non-active interpretation. This, according to Scheffler, means that the teaching is successful even if the pupil fails to aquire virtue in his own conduct. In the non-active interpretation, the behavioral acquisition of virtue is independent of the success of teaching it. Scheffler argues that both the active and the non-active interpretations of the success sense of 'teaching':

> "Allow that intellectual apprehension of moral principles and intellectual avowal of them may go together with a rejection of such principles in conduct, but one view (the active interpretation) describes such a case as a failure in teaching whereas the other (the non-active interpretation) describes it as a failure in will."[86]

86 Israel Scheffler, The Language of Education, pp. 84-85.

Scheffler concludes by stating that both the active and the non-active interpretations of the success sense of 'teaching' "recognize the actual cases recognized by the other, but describe them differently."[87] Therefore, according to Scheffler, there is no real disagreement over whether or not virtue can be taught; what is at issue is simply equivocal notions of 'successfully teaching'.

According to Scheffler, the clarification and resolution of the disagreement over successfully teaching virtue is the following: the clarification, given that virtue is knowledge, is that virtue is successfully taught (active sense) iff the pupil is virtuous in action and virtue is successfully taught (non-active sense) iff the pupil knows virtue, even though this knowledge is in no way a sufficient condition for being virtuous in action. The resolution of the disagreement is that in disagreeing over whether virtue can be taught, both sides have appealed to equivocal notions of'successfully teaching'. Provided that we clarify the notion of 'successfully teaching' by distinguishing the active and non-active senses, the disagreement over whether one is successfully taught virtue even though one is not virtuous in action becomes a failure in teaching for the

[87] Israel Scheffler, The Language of Education, p. 86.

active interpretation and a failure in will for the non-active interpretation; both describe the same phenomenon, but simply account for it with different terms, according to Scheffler's account.

Given Scheffler's account, the disagreement over whether or not virtue can be taught simply reduces to a disagreement over the description of the same phenomenon with different senses of 'successfully teaching'. However, suppose that a stubborn philosopher named Socrates argues that there is no such distinction between successfully teaching in the active and the non-active senses, and argues that one successfully teaches a pupil virtue iff the pupil is virtuous in action; otherwise, while one may be engaged in trying to teach, one is not engaged in successfully teaching the pupil. There is, in fact, no "non-active sense" of 'successfully teaching'. In this case, the disagreement is a disagreement over the nature of 'successfully teaching' and the disagreement requires further arguments giving an account of 'teaching'.

In this case, with the disagreement over the concept of teaching, we still have a genuine disagreement over whether or not virtue can be taught, assuming that both parties to the disagreement agree that virtue is knowledge.[88] Therefore, Scheffler's arguments do not show that such disagreements which reduce to disagreements over the nature of 'successfully teaching' are resolved by distinguishing what he calls the active from the non-active senses of 'successfully teaching'. A detailed account of teaching supported by arguments is required to resolve the disagreement over the nature of 'successfully teaching' and thereby to answer the questions "Can virtue be taught?" and "Can critical intelligence be taught?"

In Chapter II, I have provided arguments designed to support a clear definition of 'teaching' (D.22) in terms of 'teaching that' (D.20) and 'teaching how' (D.21). No less than a complete account of 'teaching' is sufficient to answer the question "Can critical intelligence be taught?" Anything less, like Scheffler's attempted distinction, fails to provide a satisfactory answer. We must now apply the definition of 'critical intelligence' in terms of the definition of 'critical thinking' in Chapter I to the definition of 'teaching' in Chapter II to directly determine the answer to the question "Can critical intelligence be taught?"

[88] I shall ignore the disagreement over the nature of knowing, and of knowing how and of knowing that.

A Direct Answer to the Question "Can Critical Intelligence Be Taught?"

The question "Can critical intelligence be taught?" requires some preliminary clarification. One point specifically in need of clarification is the function of 'can' in this question. For example, one may attempt to interpret 'can' in terms of a modal term like 'possible'. In this modal interpretation, to answer the question "Can critical intelligence be taught?" one simply shows that teaching critical intelligence is not logically impossible, since the modal term 'possible' includes all propositions except logically impossible ones. However, this interpretation of 'can' is disallowed by D.21. For example, given the second disjunct of D.21 (8), one cannot successfully teach y how to jump to the Moon, since D.21 (8) requires that y know how to jump to the Moon at t+1, evidenced by y jumping to the Moon at t+1. Yet jumping to the Moon is not logically impossible. Therefore, this modal interpretation of 'can' will not do.

Nor will it do to attempt to interpret 'can' in terms of some notion of physical possibility. The notion of physical possibility is extremely difficult to specify, yet even if it could be clearly specified, for example in terms of consistency with certain laws of nature, it is unnecessary to do so, given the second disjunct of D.21. For example, given D.21 (8), one cannot successfully teach y how to bench press 900 pounds unless y does know how to bench press 900 pounds at t+1, evidenced by y bench pressing 900 pounds at t+1. Bench pressing 900 pounds does not violate any physical laws, yet does not appear to be clearly "physically possible." Therefore, this interpretation of 'can' also will not do. However, given D.21 (8) and a particular form of the question "Can critical intelligence be taught?", the function of 'can' becomes clear and points toward an empirical determination of the question.

Given D.12 and D.22, the question "Can critical intelligence be taught?" may take several forms which also must be clarified in order to determine which question is being answered. For example, when asking this question, one may be interpreted as asking "Can one engage in trying to teach critical intelligence?" Yet this is an unenlightening version of the question for one interested in developing successful methods for teaching critical intelligence. Under this interpretation, for example, one can try to teach someone how to do almost anything from jumping to the Moon or bench pressing 900 pounds, to engaging correctly in critical thinking. The result of asking this question is a vacuous answer: yes.

However, there is a stronger form of the question. When one asks "Can critical intelligence be taught?", one may be interpreted as asking if it is, in fact, ever successfully taught. To answer this question, one may provide necessary and sufficient conditions for successfully doing it, and then argue that these conditions are, in fact, satisfied to provide an affirmative answer, or argue that these conditions are not, in fact, satisfied to provide a negative answer. Given D.21 (8) and the specification of these necessary and sufficient conditions for successfully teaching critical intelligence, the precise function of 'can' in this form of the question becomes a matter for empirical determination in the same way that it became a matter for empirical determination in deciding whether one can successfully teach y how to jump to the Moon, or in deciding whether one can successfully teach y how to bench press 900 pounds; that y does know how to do these things is evidenced by y doing them. Similarly, critical intelligence can be taught if these necessary and sufficient conditions are, in fact, satisfied. Therefore, the satisfaction of these necessary and sufficient conditions is a matter for empirical determination.[89]

[89] This parallels Socrates' view requiring that in order to teach virtue successfully, the pupil must, in fact, be virtuous in action. D.21 (8) therefore sides with Socrates in the dispute with other philosophers. The first disjunct of D.21 accounts for cases of teaching that are instances of trying, but failing.

'Critical intelligence' is defined by D.12 in terms of the ability to engage correctly in critical thinking. If these abilities are successfully taught according to D.21 (8), then y does know how to engage correctly in critical thinking at t+1, as evidenced by y engaging correctly in critical thinking at t+1. The success is a matter for empirical determination. It depends not only on assuming that the teacher has sufficient training and ability, but also on assuming that the student has sufficient intelligence and will.

I shall consider this stronger form of the question and answer it affirmatively by providing the necessary and sufficient conditions for successfully teaching critical intelligence, and arguing that determining the success of the teaching is, as it should be, a contingent matter. I shall then answer the question "How can critical intelligence be taught?" in Chapter IV by showing how, in fact, to satisfy these necessary and sufficient conditions for successfully teaching critical intelligence, given teachers with sufficient training and ability and students with sufficient intelligence and will. This, as it should, places questions about teaching methods and their success in guaranteeing the successful teaching of critical intelligence in the realm of empirical investigation.

Given teachers with sufficient training and ability and students with sufficient intelligence and will, we may specify the necessary and sufficient conditions for successfully teaching the students how to engage correctly in critical thinking.[90] X is engaged in successfully teaching y how to engage correctly in critical thinking (from D.11) if and only if x is engaged in successfully teaching y how (according to the second disjunct of D.21) to engage correctly in critical thinking. This can be seen as follows:

D.23 x is engaged in successfully teaching y how to engage correctly in critical thinking to degree N at t iff

(1) x believes at t that y does not know how to engage correctly in critical thinking to degree N at t-1, and

(2) x intends that y does know how to engage correctly in critical thinking to degree N at t+1, or someone intends that x bring it about that y does know how to engage correctly in critical thinking to degree N at t+1, and

(3) y does not know how to engage correctly in critical thinking to degree N at t-1 and if x does not engage in providing a model between t-1 and t+1 for y to engage correctly in critical

[90] The notion of the degree N of the ability to engage in critical thinking, determined in terms of the degree n of the specific abilities, is meant not only to account for differences due to training, but also to capture and account for contingent differences in the intelligence, ability and will of students as well as the contingent differences in the intelligence, ability and training of teachers. Therefore, I do not consider these contingent, empirical factors.

thinking to degree N, then y does not know how to engage correctly in critical thinking to degree N at t+1. and

(4) x does engage in providing a model between t-1 and t+1 for y to engage correctly in critical thinking to degree N, and

(5) y does know how to engage correctly in critical thinking to degree N at t+1 evidenced by y engaging correctly in critical thinking to degree N at t+1,

where x provides a model for y to engage correctly in critical thinking to degree N iff x intends, or some z intends that x make evident the applications of the rules according to which someone can engage correctly in critical thinking to degree N.

D.23 offers necessary and sufficient conditions for succeeding in teaching how to engage correctly in critical thinking. To determine the specific abilities, necessary and sufficient for having the ability to engage correctly in critical thinking, we need only refer to D.11 and apply it to expand D.23. This can be clarified as follows:

D.24 x is engaged in successfully teaching y how to engage correctly in critical thinking to degree N at t iff x is engaged in successfully teaching y at t how correctly to

(1) perform deductive operations according to the rules of some deductive logical system that is both consistent and truth preserving, or perform inductive operations according to some rules of inductive support; to degree n, or

(2) formulate plausible interpretations of a given statement or set of statements in which terms from the given statement or set of statements

differ in meaning in the plausible interpretations, or a statement differs in meaning or truth value in the plausible interpretations; to degree n, or

(3) determine that a proposed explicatum of a term used by an author or speaker, or a proposed clarification of a statement presented by an author or speaker is, in fact, an explicatum or is, in fact, a clarification; to degree n; or

(4) provide and evaluate deductive support (according to the rules of some deductive logical system that is both consistent and truth preserving) for given statements not necessarily translated into the language of that system or to provide and evaluate inductive support (according to some rules of inductive support) for given statements; to degree n; or

(5) recognize (psychologically persuasive) errors in formal reasoning that employs natural language, to degree n, or

any combination of (1), (2), (3), (4) and (5).

D.23 provides the necessary and sufficient conditions for successfully teaching correct critical thinking. It, therefore, according to D.12, provides the necessary and sufficient conditions for successfully teaching critical intelligence. D.24 provides a clarification of D.23 in terms of D.11 by providing the abilities which must be successfully taught according to the second disjunct of D.21 for correct critical thinking to be successfully taught.

The question "Can critical intelligence be taught?" becomes a manageable empirical question; can these abilities from D.11 in D.24 be taught successfully? We know that they can, given that they, in fact, satisfy the second disjunct of D.20 or the second disjunct of D.21. This will become, as it should, a contingent matter of empirical fact.

Consider D.24 (1). Can (1)[91] be successfully taught? According to the second disjunct of D.21:

D.25 x is engaged in successfully teaching y correctly to (1) at t iff

(1) x believes at t that y does not know how correctly to (1) at t-1, and

(2) x intends that y does know how correctly to (1) at t+1, or someone intends that x bring it about that y does know how correctly to (1) at t+1, and

(3) y does not know how correctly to (1) at t-1 and if x does not engage in providing a model between t-1 and t+1 for y correctly to (1), then y does not know how correctly to (1) at t+1, and

(4) x does engage in providing a model between t-1 and t+1 for y correctly to (1), and

(5) y does know how correctly to (1) at t+1, evidenced by y correctly doing (1) at t+1,

where x provides a model for y correctly to (1) iff x intends or some z intends that x make evident the applications of the rules according to which someone can correctly do (1).

Disjunct (1) can be taught successfully provided that these conditions in D.25 are, as a matter of empirical fact, met. For example, we do successfully teach some students

[91] The numbers are the same for D.11 and D.24. I shall use the numbers as abbreviations for these conditions in the discussion that follows.

correctly to perform deductive operations according to the rules of some deductive logical system that is both consistent and truth preserving in elementary logic courses. We do successfully teach some students correctly to perform inductive operations according to some rules of inductive support in elementary science courses. We also test students to determine whether they can do these things correctly, and our determination that they can do them to degree n is based upon their actually doing them to degree n in a test situation. Therefore (1) is the kind of ability that can be taught successfully.

Consider D.24 (2). Can (2) be successfully taught? Disjunct (2) can be taught successfully provided that the conditions in D.25 are, as a matter of empirical fact, met, when substituting (2) for (1). It seems that these conditions are, in fact, met. For example, we do successfully teach some students correctly to formulate plausible interpretations of a given statement or set of statements in which terms from the given statement or set of statements differ in meaning in the plausible interpretations, or a statement differs in meaning or truth value in the plausible interpretations, in elementary philosophy courses. We also test students to determine whether they can correctly decide if a term or statement is unclear in a given context, correctly consider logical and factual relationships among presented statements, and produce alternative construals of the meaning of terms or the meaning or truth value of the statement. Our determination that they can do this to degree n is based upon their actually doing this to degree n in a test situation. Therefore, (2) is the kind of ability that can be taught successfully.

Consider D.24 (3). Can (3) be successfully taught? Disjunct (3) can be taught successfully provided that the conditions in D.25 are, as a matter of empirical fact, met when substituting (3) for (1). It seems that these conditions are, in fact, met. For example, we do successfully teach some students correctly to determine that a proposed explicatum of a term used by an author or speaker, or a proposed clarification of a statement presented by an author or speaker is, in fact, an explicatum or is, in fact, a clarification in introductory or intermediate philosophy courses. We also test students to determine whether they can evaluate a proposed explication of a term by appeal to the rules of explication, or a proposed clarification of a statement by appeal to some rules of clarification. Our determination that they can do this to degree n is based upon their actually doing this to degree n in a test situation. Therefore (3) is the kind of ability that can be taught successfully.

Consider D.24 (4). Can (4) be successfully taught? Disjunct (4) can be taught successfully provided that the conditions in D.25 are, as a matter of empirical fact, met when substituting (4) for (1). It seems that these conditions are, in fact, met. For example, we do successfully teach some students correctly to provide and evaluate deductive support (according to the rules of some deductive logical system that is both consistent and truth preserving) for given statements not necessarily translated into the language of that system, or to provide and evaluate inductive support (according to some rules of inductive support) for given statements, in logic, philosophy or science courses. In such courses we also test students to determine whether they can correctly evaluate a clear statement of a theory by correctly performing deductive operations on statements of the theory, or correctly provide deductive arguments to support the theory or refute the theory; to determine correctly whether they can correctly translate statements into formal language to prove that a theory is consistent, or to show that it is inconsistent, or correctly to prove that the arguments supporting a theory are valid or to show that they are invalid, or, by performing inductive operations on statements of the theory, to support the theory or to refute the theory. Our determination that they can do this to degree n is based upon their actually doing this to degree n in a test situation. Therefore, (4) is the kind of ability that can be taught successfully.

Consider D.24 (5). Can (5) be successfully taught? Disjunct (5) can be taught successfully provided that the conditions in D.25 are, as a matter of empirical fact, met when substituting (5) for (1). It seems that these conditions are, in fact, met. For example, we do successfully teach some students correctly to recognize psychologically persuasive errors in formal reasoning that employs natural language in introductory philosophy and communications courses. We test students to determine whether they can correctly recognize informal fallacies by producing the rule that the fallacy in question is an instance of. Our determination that they can do this to degree n is based upon their actually doing this to degree n in a test situation. Therefore (5) is the kind of ability that can be taught successfully.

Consider, finally, any combination of D.24 (1), (2), (3), (4) and (5). Can doing any combination of (1), (2), (3), (4) and (5) be successfully taught? Doing any combination of these can be taught successfully provided that each of (1) through (5) can be taught successfully. Since I have shown that each of (1) through (5) can be taught successfully, it follows that doing any combination of these can be taught successfully.

Therefore, since each of the abilities to degree n for engaging correctly in critical thinking to degree N can be taught, the ability to engage correctly in critical thinking to degree N can be taught. Therefore, given D.12, defining the degree N of critical intelligence in terms of the degree N of the ability to engage correctly in critical thinking, critical intelligence can be taught successfully.

With the strong form of the question "Can critical intelligence be taught?" answered affirmatively, we are now in a position to provide a clear answer to question 4 "How can critical intelligence be taught?"

CHAPTER IV

HOW CAN CRITICAL INTELLIGENCE BE TAUGHT?

To ask how critical intelligence can be taught is, according to D.12, to ask how correct critical thinking can be taught. Yet the question "How can critical thinking be taught?" has been interpreted in at least two ways by educators attempting to answer it. First, some educators have interpreted the question as asking for a method for teaching such that teaching by this method is a sufficient condition for teaching critical thinking. Many educators have attempted to answer this interpretation of the question by proposing methods designed, when teaching is done by them, to be sufficient conditions for teaching critical thinking. Secondly, some educators have interpreted the question as asking for a curriculum to teach such that teaching this curriculum is a sufficient condition for teaching critical thinking. Many educators have attempted to answer this interpretation of the question by proposing curricula designed, when taught, to be sufficient conditions for teaching critical thinking.

Educators attempting to answer the question "How can critical thinking be taught?" can, accordingly, be divided into two groups. The first group includes those attempting to answer the question by providing a method designed, when teaching is done by it, to be a sufficient condition for teaching critical thinking. The second group includes those attempting to answer the question by providing a curriculum designed, when taught, to be a sufficient condition for teaching critical thinking. Rather than consider all proposed methods in group one, and all proposed curricula in group two, I shall critically consider a representative sample from each group.[92]

[92] Other authors offering accounts similar to one or more of the accounts I consider in group one are: M. L. Marksberry, "Kindergarteners are Not Too Young," Elementary School Journal, No. 66 (Oct. 1965), pp. 13-17; J. Shotka, "Critical Thinking in the First Grade," Childhood Education, No. 36 (May 1960), pp. 405-09; J. C. Aldrich, "Developing Critical Thinking," Social Education, No. 12 (March 1948), pp. 115-18; F. T, Arone, "Developing Critical Thinking in Junior High School," Clearing House, No. 34 (April 1960), pp. 456-61; E. Dale, "Teaching Critical Thinking," Education Digest, No. 24 (May 1959), pp. 29-31; K. B. Henderson, "Teaching of Critical Thinking," Phi Delta Cappan, No. 39, (March 1958), pp. 280-82; A. Milton, "Method for Teaching Thinking," The English Journal, No. 27 (Oct. 1938), pp. 660-66; B. O. Smith "Improvement of Critical Thinking," Progressive Education, No. 30 (March 1953) pp. 129-34. Other authors offering accounts similar to one or more of the accounts I consider in group two are: W. S. Howell, "The Effects of High School Debating on Critical Thinking," Speech Monographs, No. 10 (1943), p. 100; R. Karlin, "Critical Reading is Critical Thinking," Education, No. 17 (Sept. 1963), pp. 9-11; A. O. Kownslar, "Fact or Fiction in History: Vehicles for Critical Thinking," Clearing House , No. 41 (Sept. 1966), pp. 18-20; G. R. Greutz and K. I. Grezi, "Developing Critical Thinking in the Current Events Class," Journal of Educational Research, No. 58 (April 1965), pp. 366-67; H. E. Kelley, "The Thinking Process in Relation to Arithmetic," Ohio Schools, No. 17 (June 1939), p. 281; K. B. Henderson and M. P. Fulton, "Critical Thinking: Geometry Classes Use Radio Programs," Clearing House ,

I shall argue that the methods offered by educators in the first group are not sufficient conditions for teaching critical thinking, and that simply teaching by some method is not a sufficient condition for teaching critical thinking without a curriculum which, when taught, is a sufficient condition for teaching critical thinking. I shall then argue that teaching the curricula offered by educators in the second group is not a sufficient condition for teaching critical thinking, yet a curriculum C.3 that is a sufficient condition for teaching critical thinking can be provided by an appeal to D.10. I shall argue that if we interpret the question as asking for a curriculum for successfully teaching correct critical thinking, then C.4 can be provided in terms of D.20, D.21, and directly by D.24. I shall then provide a complete, detailed curriculum, C.4, in answer to this interpretation of the question "How can critical thinking be taught?"

No. 24 (Nov. 1949), pp. 155-58; E. R. Downing "Does Science Teach Scientific Thinking?," Science Education, No. 17 (April 1933), p. 89; C. M. Dunning, "Developing Critical Thinking Through Elementary Science," School Science and Mathematics, No. 51 (Jan. 1951), pp. 61-63; P. M. Smith, Jr., "Critical Thinking and the Science Intangibles," Science Education, No. 47 (Oct. 1963), pp. 405-08. Note also that all the educators considered in Chapter I, providing definitions of 'critical thinking' may also be construed as attempting to provide such curricula.

Then I shall argue that to ask for some method for how to teach C.4 is simply to ask for some method such that it satisfies the second disjunct of D.20 and the second disjunct of D.21. I shall conclude that the selection of such a method, given this requirement, is simply a matter of empirical consideration, depending on contingent factors such as the personality and individual strengths of the teacher, the size and length of the class, and the background and the ability of the students and the degree N to which critical thinking is taught. I shall then, in the appendix, provide a detailed model in terms of this complete detailed curriculum C.4, and in terms of a method that satisfies the second disjunct of D.20 and the second disjunct of D.21, for how to teach critical intelligence.

Proposed Teaching Methods: Group One

Bernard Mehl proposes a method for teaching critical thinking that has two component methods. The first he calls "the creative discovery method" and the second he calls "the double-dare-you method."[93] The goal of this method composed of these two component methods is, according to Mehl, to

[93] B. Mehl, "Motiviation of Critical Thinking," Progressive Education, No. 33 (Jan. 1956), pp. 12-15.

motivate students to think critically and "not to behave like parrots, robots or Univacs."[94] This "motiviation," he claims, "is part of the teaching method and cannot be separated from it."[95]

In the method of creative discovery, the student "is given a chance to discover relationships by himself. The teacher sets the stage, so the student will think through conclusions to the problem studied by means of his own creative experience."[96] The teacher then simply presents material related such that the relations are unstated and allows the student to discover these relations. Mehl considers the relation of "being incompatible with" and offers an example. In his example, the teachers ask for a list of the racial characteristics of Mongolians, Negros, and Caucasions.[97] He then asks for a list of the political, religious, and racial characteristics of various nationalities. He may then, given the reply, for example, that Americans are Republicans, Protestant and white, elicit information that

[94] B. Mehl, "Motivation of Critical Thinking," p. 13.

[95] B. Mehl, "Motivation of Critical Thinking," p. 14.

[96] B. Mehl, "Motivation of Critical Thinking," I take it he means to say "think through problems to the conclusion," unless he means to say "study the arguments to see if they are valid and sound."

[97] One might modify the example such that a contradiction results.

is incompatible with this reply. The students must then discover and point out this incompatibility. Mehl claims that in the method of creative discovery, the teacher "may direct their attention to the slip, but if the students do not pick up the cue, he must formulate another scheme by which the revelation can come from the student. Note that the teacher does not force the conclusion on the class."[98] Therefore, according to Mehl, in the creative discovery method, "the teacher brings into the teaching picture elements which he knows can be spotted as incompatible with each other by the average student."[99]

In the double-dare-you method, the student is challenged to justify his position on a particular issue. The teacher then raises a controversial issue, or states a proposition which he believes at least some students believe is false. Mehl claims that "when a student can't accept a proposition . . . and . . . counters with his own notion, the teacher challenges the student to prove his own contention. The important thing here is to gauge the challenge so that it is either within the student's range or just beyond it."[100] The object of the double-dare-you method, then, is

[98] B. Mehl, "Motivation of Critical Thinking," p. 15.

[99] B. Mehl, "Motivation of Critical Thinking," p. 15.

[100] B. Mehl, "Motivation of Critical Thinking," p. 15.

to provide a situation in which the student is challenged to produce arguments to prove his point. He will also, according to Mehl, be forced to examine his position in terms of various alternative positions. According to Mehl, "'I bet you can't do it' (is a phrase) . . . used by parents as they attempt to get their children to clean up the yard, wash dishes, or perform other distasteful chores. The teacher who wishes to motivate for critical thinking can do well to borrow a page out of the parent's manual to effect participation in a far from distasteful task."[101]

This method, composed of these component methods, may be summarized as follows:

M.1 x is engaged in teaching y how to engage in critical thinking if x is engaged in

(1) presenting y materials related such that some presented material is incompatible with other presented material such that the incompatibility is unstated and such that y is encouraged by x to discover and state this incompatibility (creative discovery component), or

(2) presenting y issues or propositions such that y is challenged to take a stand on the issue, or produce an alternative proposition, and to justify this stand or support this alternative proposition with arguments (double-dare-you component).

[101] B. Mehl, "Motivation of Critical Thinking," p. 15.

M.1 is stated such that both the creative discovery component and the double-dare-you component are sufficient conditions for teaching critical thinking. There are, however, difficulties with M.1. Neither what Mehl calls creative discovery (M.1 (1)) nor what he calls the double-dare-you component (M.1 (2)) are sufficient conditions for teaching critical thinking.

Consider M.1 (1). Suppose that x asks for a list of the racial characteristics of Mongolians, Negroes and Caucasions. X then asks for a list of the political, religious, and racial characteristics of Americans, and receives the reply "Republican, Protestant and white." In accord with the creative discovery component, x now asks for the political, religious and racial characteristics of Harlem ghetto dwellers and receives the reply "Communist, Moslem and black." After some prodding and cues by x, suppose that y raises his hand and states his discovery that "Republican, Protestant and white Americans are incompatible with Communist, Moslem and black Americans". However, y has not committed a use-mention confusion since y intends his statement as an explanation for political, religious and racial strife, not as a statement intended to point out the inadequacy of characterizing Americans as Republican, Protestant and white. M.1 (1) is satisfied, yet even according to D.10, y is not engaged in critical thinking. At most, y is engaged in creative thinking. Therefore, M.1 (1) is not a sufficient condition for teaching how to engage in critical thinking.

Consider M.1 (2). Suppose that x states that "blacks are not inferior to whites." Now suppose that x challenges y to justify this proposition with arguments, and y replies that "all men are created equal." We may want to claim that y is indeed engaged in creative thinking, but y is not engaged in critical thinking, even according to D.10. In simply proposing this proposition, y does not engage in evaluating any arguments. M.1 (2) also confuses engaging in critical thinking with engaging in creative thinking. Therefore, the double-dare-you component is not a sufficient condition for teaching how to engage in critical thinking. Therefore, M.1 fails as a method for guaranteeing the teaching of critical thinking.

Herbert Thelen also proposes a method for teaching critical thinking that is called "the method of confrontation."[102] Thelen states that "inquiry . . . starts

[102] H. Thelen, "Materials That Promote Inquiry and Thinking," Educational Screen and Audiovisual Guide, No. 44 (Dec. 1965), p. 26.

with the arrest of attention - a confrontation of some sort . . ."[103] He then proposes four ways to arrest the student's attention with confrontations designed to teach critical thinking.

The first way is to demonstrate an experiment without explanation. According to Thelen, this requires the student to observe carefully and to engage in critical thinking to answer the teacher's questions. Then, according to Thelen,

> "I'd ask 'What was my hypothesis, what were my data, and what have I shown?' . . . you tell the class too little and demand that they fill in the gaps in some way, but you don't tell them how. In genuine inquiry, it doesn't matter whether speculations are "good" or "bad" or antisocial; so long as they close the gap."[104]

The second way Thelen mentions is to overwhelm students with different ideas and material. In this way, students confront these ideas and material and exercise critical thinking to organize them. According to Thelen, "you require them to sort out, categorize, and abstract an idea from the jumble of impressions."[105] The third way Thelen mentions is to

[103] H. Thelen, "Materials That Promote Inquiry and Thinking," p. 26.

[104] H. Thelen, "Materials That Promote Inquiry and Thinking," p. 26.

[105] H. Thelen, "Materials That Promote Inquiry and Thinking," p. 26.

violate the student's expectations. "You make sure the class has . . . a good idea of what is going to happen and then you arrange it so the opposite happens."[106] This confronts them with something that requires explanation, since it violates the pattern they have come to expect. This explanation, according to Thelen, requires critical thinking. The fourth way Thelen mentions is to confront the students with a problem, and then "ask how can we investigate this problem?" Thelen claims that "any good problem can be investigated in a million ways. There is no reason why everybody should do the same thing, so let them do what is interesting to them."[107] According to Thelen, in generating alternative methods for investigating this problem, the students are exercising critical thinking.

The method of confrontation may be summarized as follows:

M.2 x is engaged in teaching y how to engage in critical thinking if x is engaged in arresting y's attention by confronting y with

(1) a demonstration without explanation such that y is required to observe the demonstration carefully, and x asks y "gap filling" questions that y answers such as "What has the demonstration shown?, What is the evidence presented?," etc., or

[106] H. Thelen, "Materials That Promote Inquiry and Thinking," p. 26.

[107] H. Thelen, "Materials That Promote Inquiry and Thinking,", p. 26.

(2) overwhelming materials or ideas such that y is required to sort out, categorize and abstract an idea from them, or

(3) a violation of y's expectations such that y is required to explain this violation of the expected pattern, or

(4) a problem such that y is required to propose a method for solving the problem.

M.2 is stated such that Thelen's four ways to arrest student's attention by confrontation are each sufficient conditions for teaching critical thinking. There are, however, also difficulties with M.2. The methods Thelen groups as the method of confrontation, specified in M.2 (1), (2), (3) and (4), are not sufficient conditions for teaching critical thinking. Consider M.2 (1). Observing a demonstration, then answering what Thelen calls "gap filling questions" may involve creative thinking, but it does not involve critical thinking. Critical thinking, according to D.10, may occur only after we are given a statement of what the demonstration has shown. This may then, for example, be critically evaluated according to D.10 (1). However, M.2 (1) simply involves creative thinking in terms of discovering what the demonstration has shown, but does not involve creative thinking. Therefore, M.2 (1) is not a sufficient condition for teaching critical thinking.

Consider M.2 (2). Sorting out, categorizing and abstracting an idea from overwhelming materials or ideas may also require that one discover a pattern, but this discovery requires creative thinking, not critical thinking. Critical thinking, according to D.10, may occur only after we are given a statement of the pattern. This may then, for example, be critically evaluated according to D.10 (4). However, M.2 (2) simply involves creative thinking in terms of discovering the pattern in data, but not critical thinking. Therefore, M.2 (2) is not a sufficient condition for teaching critical thinking.

Consider M.2 (3). Explaining a violation of an expected pattern also involves creative thinking, but does not involve critical thinking. Critical thinking, according to D.10, may occur only after we are given an explanation of this violation. M.2 (3) simply involves creative thinking in terms of explaining the violation of expectations, but not critical thinking. Therefore M.2 (3) is not a sufficient condition for teaching critical thinking.

Consider M.2 (4). Proposing a method to solve a problem also requires creative thinking, but it does not involve critical thinking. Critical thinking, according to D.10, may only occur given a proposed solution to a problem. This may then, for example, be critically evaluated according to

D.10 (3) or (4). However, M.2 (4) simply involves creative thinking in terms of proposing a method to solve a problem but not critical thinking. Therefore, M.2 (4) is not a sufficient condition for teaching critical thinking.

Like Mehl, Thelen also confused critical thinking with creative thinking. Therefore, teaching by the method of confrontation is not a sufficient condition for teaching critical thinking. M.2 also fails as a method for guaranteeing the teaching of critical thinking.

Rubin Gotesky also proposes a method for teaching critical thinking that can be called the lecture method.[108] Gotesky asks:

> "Can the ordinary classroom lecture be so organized that it will stimulate the student to ask "do conclusions follow directly from the evidence? If they do not, what sort of evidence is needed? And where the arguments are not conclusive and differences of opinion exist, what is the real problem, issue or issues?'"[109]

His answer is yes, the lecture can be used as a method to teach critical thinking.

[108] R. Gotesky, "The Lecture and Critical Thinking," Education Forum, No. 30 (Jan. 1966), pp. 179-187.

[109] R. Gotesky, "The Lecture and Critical Thinking," p. 182.

Gotesky lists three devices that make up the lecture method. First, the lecturer may present false information or data, according to Gotesky,

> "To determine whether the student can detect their presence from true information in his possession. The employment of such false information or data must be carefully assessed in terms of . . . a) degree of implausibility, b) logical contradiction, and c) irrelevance."[110]

Secondly, the lecturer may present what he calls misleading data. Misleading data, according to Gotesky,

> "Is data that tends to arouse unjustified inferences in the student. This can be done a) by surrounding such data with emotion arousing expressions, b) by insinuating conclusions not actually expressed, through over emphasis upon such data, c) by stating such data in ambiguous language, and d) by failing to provide a clear meaning for technical words or expressions which lead the student to derive conflicting conclusions."[111]

Thirdly, the lecturer may present arguments drawing irrelevant or contradictory conclusions.

However, simply presenting false information, misleading data or drawing irrelevant or contradictory conclusions in

[110] R. Gotesky, "The Lecture and Critical Thinking," p. 184.

[111] R. Gotesky, "The Lecture and Critical Thinking," p. 186.

a lecture does not insure teaching critical thinking. Gotesky also states that

> "to use these devices, a lecturer must know exactly what he is doing. He must know exactly when to use false data, misleading data, or irrelevant conclusions. Moreover . . . he must know exactly how his assignments are logically related to his lecture . . . he must know exactly where in his lecture and assignments data and conclusions are in conflict. Last, <u>he must employ pedagogic devices that place the student in the position to discover false or misleading information, or irrelevant or implausible conclusions.</u>"[112]

It is intuitively clear that lectures embodying false information or data, misleading data, or irrelevant or contradictory conclusions may provide subject matter for the application of critical thinking, according to D.10. However, it is not clear that the lecture method described by Gotesky is a sufficient conditon for teaching critical thinking. He requires that the teacher "place the student in the position to discover false or misleading information, or irrelevant or implausible conclusions."[113] Yet such a requirement is simply a requirement that the teacher teach the student how to engage in critical thinking. This is both a requirement for the proper use of the lecture method and the proposed result of the lecture method. The lecture

[112] R. Gotesky, "The Lecture and Critical Thinking," p. 187, my emphasis.

[113] Quoted above, emphasis.

method, therefore, is not a method for teaching critical thinking at all since critical thinking ability is required for its proper use. It is more usefully seen as a means of testing for, or exercising critical thinking, once the student is "placed in the position" Gotesky mentions. Simply confronting the student with subject matter for the application of critical thinking is not a sufficient condition for teaching critical thinking skills. The question is not simply "How can teachers place students in a situation where if they know how to engage in critical thinking, they would?" The question is "How can teachers teach students how to engage in critical thinking?" Gotesky has answered the first question but has failed to answer the second. Therefore, Gotesky has not provided a method for teaching critical thinking.

Gotesky's and similar attempts to teach critical thinking simply by teaching according to some method like M.1 or M.2 fail because they fail to specify what is to be taught by the method. It appears that for any such method to be effective, a curriculum is required in order to specify what is to be taught by the method. The curriculum, therefore, appears to need careful specification before any specification of method. This can be seen intuitively by seeing that one must know what to teach before one can ask for some method for how to teach it.

Given the specification of some curriculum, the specification of some method will then be determined according to the definition of teaching and the specific curriculum to be taught. A concern for providing a method without a concern for providing a curriculum is like a concern for providing transportation without a concern for providing a destination. We must, therefore, consider the alternative curricula designed, when taught, to be sufficient conditions for teaching critical thinking.

Proposed Curricula: Group Two

Several educators have attempted to answer the question "How can critical thinking be taught?" by providing curricula designed for teaching critical thinking. The concern here is to provide material that, when taught to students, is sufficient to teach them critical thinking.

H. A. Anderson proposes that specific material in English instruction be used to teach critical thinking.[114] He cites

[114] H. A. Anderson, "Critical Thinking Through Instruction in English," The English Journal, No. 36 (Feb. 1947), pp. 73-80.

"three aspects or phases of the English curriculum . . . which contribute effectively to teaching critical thinking."[115] The first aspect he calls "normal situations for communication." According to Anderson,

> "One of the prime prerequisites for increasing competence in language communication and developing critical thinking is provision for abundant opportunities for speaking, listening, reading, and writing in normal, meaningful situations."[116]

Such "meaningful situations" occur, according to Anderson, "only when the student 1) has something to say, 2) has a reason for saying it, 3) has someone to whom to say it, and 4) has the facility for saying it."[117] These opportunities for speaking, listening, reading and writing then make up what Anderson calls "normal situations for communication."

The second aspect Anderson calls "the nature of language." According to Anderson, teachers of English

[115] H. A. Anderson, "Critical Thinking Through Instruction in English," p. 74.

[116] H. A. Anderson, "Critical Thinking Through Instruction in English," p. 74.

[117] H. A. Anderson, "Critical Thinking Through Instruction in English," p. 75.

> "Attempt to develop critical thinking through English instruction by giving children . . . a better understanding of language as a social institution and as a psychological process."[118]

According to Anderson, teaching language as a social institution and a psychological process involves teaching "the nature and function of language as an instrument of communication . . . vocabulary . . . how words get meaning, and how experiences are attached to printed and spoken symbols."[119]

The third aspect Anderson calls "instruction in grammar." According to Anderson, "grammar, properly taught, will improve written and oral discourse and the ability to read and listen."[120] He claims that "understanding principles of word order of sentences, the functional relationships among words, principles of modification of ideas, of the coordination and subordination of ideas in sentences . . . will do much to clarify thinking and expression."[121]

[118] H. A. Anderson, "Critical Thinking Through Instruction in English," p. 75.

[119] H. A. Anderson, "Critical Thinking Through Instruction in English," p. 76.

[120] H. A. Anderson, "Critical Thinking Through Instruction in English," p. 78.

[121] H. A. Anderson, "Critical Thinking Through Instruction in English," p. 78.

The curriculum for teaching critical thinking proposed by Anderson can be more clearly seen as follows:

C.1 x is engaged in teaching y how to engage in critical thinking if x is engaged in teaching y

(1) by giving y opportunities for speaking, listening, reading, and writing such that y has something to say, hear or read, and y has a reason for saying, hearing, or reading it, and y has some z to speak to or listen to, and y has the facility for saying, listening and reading, or

(2) to better understand language as a social institution and as a psychological process; how words get meaning and how experiences are attached to printed or spoken symbols, or

(3) the principles of word order, the functional relationships among words in a sentence and the principles of the modification or subordination of ideas.

C.1 is stated such that teaching (1), (2) or (3) (Anderson's three aspects of the English curriculum) is a sufficient condition for teaching critical thinking. There are, however, difficulties with C.1. Teaching any or all of the three aspects of the English curriculum Anderson cites is not a sufficient condition for teaching critical thinking. Consider C.1 (1). Suppose that in an English course, Richard Nixon is saying to the class that he was hounded from office by the press, is listening to Rabbi Buruch Korff agree, is reading early James J. Kilpatrick columns, and is writing his memoirs to establish his role in history as a great moral leader. However, the teacher in teaching Nixon by giving him these opportunities for speaking, listening, reading, and writing is certainly not engaged in teaching Nixon how to engage in critical thinking; at most he is giving him the opportunity to exercise his delusions. Therefore, C.1 (1) is not a sufficient condition for teaching critical thinking.

Consider C.1 (2). Again, suppose that the English teacher teaches Nixon to better understand language as a social institution and as a psychological process, how words get meaning and how experiences are attached to printed and spoken symbols. Suppose that Nixon then provides an account in his memoirs showing how the language used by his enemies affected public opinion concerning his guilt, showing how the language used by his enemies showed an obsession with his impeachment, and that he provides an etymology of 'crook' and argues that 'Nixon' and 'crook' have different linguistic sources and functions and that 'Nixon' is not 'crook'. The teacher engaged in teaching Nixon to better understand language as a social institution and as a psychological process, how words get meaning and how experiences are attached to printed and spoken symbols, is certainly not engaged in teaching Nixon how to engage in critical thinking. Therefore, C.1 (2) is not a sufficient condition for teaching critical thinking.

Consider C.1 (3). Suppose that Rabbi Korff is helping Nixon apply the principles of word order, the functional relationships among words in a sentence and the principles of the modification or subordination of ideas taught by the English teacher. Nixon applies these principles while writing the section of his memoirs tracing his development as a great moral leader. The teacher engaged in teaching Nixon these principles is certainly not engaged in teaching Nixon how to engage in critical thinking. Therefore, C.1 (3) is not a sufficient condition for teaching critical thinking. Therefore, Anderson has not cited aspects of an English curriculum which, when taught, are sufficient for teaching critical thinking.

Earl Murry proposes that specific material from a mathematics curriculum be used to teach critical thinking.[122] Murry's concern is to use a basic geometry course to teach critical thinking by teaching what he calls "conflicting assumptions." According to Murry,

> "This particular phase of thinking which is so essential to life adjustment is very likely to be neglected in a geometry course because we have thought of our assumptions as being self-evident truths which were unchangeable."[123]

[122] E. Murry, "Conflicting Assumptions," The Mathematics Teacher, No. 37 (Feb. 1944), pp. 57-63.

[123] E. Murry, "Conflicting Assumptions," p. 57.

Murry's announced goal in teaching critical thinking by teaching what he calls "conflicting assumptions" are first, to teach students to select underlying assumptions, and secondly, to determine their consistency with a particular conclusion.[124]

He offers the study of parallel lines in geometry as an example of "conflicting assumptions." Murry presents what he calls "the assumptions" that Euclid, Riemann and Lebachevsky made about parallel lines. He claims that Euclid assumed that through a given point, one line could be drawn parallel to a given line, that Riemann assumed that through a given point, no line could be drawn parallel to a given line, and that Lobachevsky assumed that through a given point, two lines could be drawn parallel to a given line.[125] Murry then claims that from these "conflicting assumptions," one derives contradictory conclusions. For example, in Euclidean geometry, the sum of the angles of a triangle equals 180°, while in Riemannian geometry, the sum of the angles is more than 180°, and in Lobachevskian geometry, the sum of the angles is less than 180°. According to Murry,

[124] E. Murry, "Conflicting Assumptions," p. 61.

[125] E. Murry, "Conflicting Assumptions," p. 58.

"It is obvious that these conflicting assumptions lead to conflicting conclusions . . . the greatest outgrowth of the study is to notice that changing our assumptions leads us to entirely different conclusions even though no error is made in our thinking. In other words, our conclusions are dependent upon our assumptions and no conclusion can be any more reliable than the assumption upon which it is based."[126]

Murry then considers the "use of assumptions in everyday life." Students are asked to determine the assumptions underlying their behavior of walking or running in the halls, obeying or disobeying traffic laws, etc.

Given this discussion, Murry seems to mean by 'assumption' anything from 'suppressed premise in an argument using ordinary language' to 'hypothesis or axiom in mathematics'. Given this looseness and flexibility in the use of 'assumption', Murry seems to be making a fairly safe point; that two deductively valid arguments can reach either contrary or contradictory conclusions, and that this can be explained by the choice of the premises, not by the rules of valid inference.

The curriculum for teaching critical thinking proposed by Murry can be more clearly seen as follows:

126 E. Murry "Conflicting Assumptions," p. 58.

C.2 x is engaged in teaching y how to engage in critical thinking if x is engaged in teaching y

(1) to recognize and to state underlying assumptions; suppressed premises in ordinary language, or hypotheses or axioms in mathematics, or

(2) to determine if a given underlying assumption is logically consistent with a given conclusion.

C.2 is stated such that teaching (1) or (2) is a sufficient condition for teaching critical thinking. There are, however, difficulties with C.2. Teaching (1) or (2) is not a sufficient condition for teaching critical thinking.

Consider C.2 (1). The role of critical thinking is not simply to recognize and to state such underlying assumptions, but to evaluate them, in hopes of determining, according to (1) through (5) b) of D.10, if the statement or the assumption is true. Again, we may recognize and state underlying assumptions by lucky guess, intuition, or some method of discovery. The application of critical thinking to underlying assumptions, however, is not simply their discovery or statement, but also their evaluation. C.2 (1), therefore, seems to involve y in methods of discovery but not necessarily in methods of evaluation. Therefore, C.2 (1) is not a sufficient condition for teaching critical thinking.

Consider C.2 (2). A proposition is logically consistent with a proposition or set of propositions iff their conjunction is not a contradiction. However, C.2 (2) simply says that if x is engaged in teaching y to determine if a given assumption is consistent with a given conclusion, then x is engaged in teaching y how to engage in critical thinking. This, like C.2 (1), will not do without modification. For example, x will satisfy this condition by teaching y that when a spinning Coke bottle points East, the propositions under consideration are contradictory, otherwise not. In this case, however, it cannot be said that x is engaged in teaching y how to engage in critical thinking. Therefore C.2 (2), as it stands, is not a sufficient condition for teaching critical thinking. Therefore, Murry has not cited aspects of a mathematics curriculum which, when taught, are sufficient for teaching critical thinking.

These and similar attempts to specify a curriculum which, when taught, provides a sufficient condition for teaching critical thinking fail because they fail to provide a sufficient condition for teaching critical thinking. However, (1), (2), (3), (4) and (5), or any combination of (1), (2), (3), (4) and (5) of D.10 can be seen to provide a curriculum which, when taught, is a sufficient condition for teaching critical thinking. Since, given the disjuncts of D.10, engaging in each is a sufficient condition for engaging in critical thinking, engaging in teaching each is a sufficient condition for engaging in teaching critical thinking. Therefore, by appeal to D.10, we can provide an answer to the question "How can critical thinking be taught?" in terms of a curriculum which, when taught, provides a sufficient condition for teaching critical thinking. This can be seen as follows:

C.3 x is engaged in teaching y how to engage in critical thinking if x is engaged in teaching y how to

(1) a) judge whether a statement does or does not follow inductively from a presented statement or set of statements, or does or does not follow deductively from a presented statement or set of statements, or does not follow inductively or deductively from a presented statement or set of statements, and

b) to produce an appeal to inductive or deductive rules of inference to support the judgment, or

(2) a) judge whether a term or statement is unclear and requires explication or clarification, and

b) to produce more than one plausible construal of the meaning of the term or the meaning of the statement to support the judgment, or

(3) a) judge whether the proposed explicatum or the proposed clarification selected explicates or clarifies what the user of the term or the author of the statement can reasonably be construed to intend, and

b) to produce an appeal to reasons for supposing that the proposed explicatum is an explicatum (by appeal to what an explication is) or an appeal to reasons for supposing that the proposed clarification is a clarification (by appeal to (2)), to support the judgment, or

(4) a) judge whether a clear statement of a theory can or cannot be supported by sound arguments, and

b) to produce either what x believes to be a valid, sound deductive or what x believes to be a strong inductive argument to support the theory, or produce either what x believes to be a valid, sound deductive, or what x believes to be a strong inductive argument to support its denial, to support the judgment, or

(5) a) judge whether a statement or a set of statements is an instance of an informal fallacy, and

b) to produce the rule which x believes the fallacy in question is an instance of, or

any combination of doing (1), (2), (3), (4) and (5).

C.3 provides an answer to the question "How can critical thinking be taught?" by providing sufficient conditions for teaching critical thinking. However, C.3 has two serious educational defects for educators interested in teaching critical thinking. First, C.2 does not limit critical thinking to correct critical thinking. Secondly, C.3 does not limit teaching to successful teaching. The educationally interesting form of the question "How can critical thinking be taught?" is, therefore, "How can <u>correct</u> critical thinking be <u>successfully</u> taught?"

The Answer: A Curriculum and the Question of Method

We may begin modification of C.3 to answer this educationally interesting form of the question by noting that given D.11, we know what it is to engage correctly in critical thinking to degree N. Furthermore, given the second disjuncts of D.20 and D.21, we know what it is to engage in successfully teaching that, and know what it is to engage in successfully teaching how. Given D.23, we know what it is to engage successfully in teaching how to engage correctly in critical thinking, and given D.24, we know this in terms of the specific abilities necessary and sufficient for having the ability to engage correctly in critical thinking. I have argued that these specific abilities can be taught because we, in fact, succeed in teaching them. We may, therefore, simply cite D.24 as the curriculum for successfully teaching correct critical thinking.

Yet D.24 is not a complete answer to the question "How can correct critical thinking be successfully taught?" A recalcitrant educator may ask, given D.24, "How can (1), (2), (3), (4) and (5) be successfully taught?" The answer to this question can be given by listing what is to be taught, according to the second disjunct of D.20 and the second disjunct of D.21, in (1), (3), (3), (4) and (5). The answer, then, is "by successfully teaching these specific propositions, and by successfully teaching these specific skills." This can be seen, in detail, as follows:

C.4 x is engaged in successfully teaching y how to engage correctly in critical thinking to degree N at t if x is engaged in successfully teaching y

(1) that arguments consist of statements called premises and statements called conclusions, that statements have a logical form; that the logical form of statements can be captured in PC by propositional letters and logical connectives; that capturing the logical form of statements is called translating the statement from ordinary language into a formal language, either PC or LPC; that a given statement is either true or false and not both; that proposition letters are used univocally; that the logical connectives are $\cdot$, v, $\sim$, $\supset$, $\equiv$, and are derivable from just $\sim$ and $\cdot$; that the logical connectives can, in turn, be defined contextually by truth tables; that truth tables can also be used to define 'logical equivalence', 'contradiction' and 'tautology'; and the logical form of statements can be captured in LPC with predicate constants, quantifiers successfully representing all, some, and none,[126] the logical connectives, and relation constants; the predicate constants replace predicates like red, old, bald, etc.; that universal quantifiers are defined in terms of domain D and conjunction ($\cdot$), and that existential quantifiers are defined in terms of domain D and disjunction (v); that relation constants replace relations like between, to the left of, is identical with, etc.; that relations may be symmetrical, asymmetrical, transitive, intransitive, reflexive, irreflexive or totally reflexive; that identity is a special kind of relation; that identity is transitive, symmetrical, and totally reflexive; that identity allows us to capture the logical form of statements including "exceptive" statements, "at most" statements, "no more than"

[126] Many logicians before Frege had unsuccessfully attempted to represent all, some, and none. However, not until Frege published the Begriffsschrift (Concept Ideography) was an attempt provably successful.

statements, "exactly one" statements, "exactly two" statements; that identity also allows us to capture the logical form of definite descriptions; that definite descriptions functioning in arguments as proper names are usually denoting definite descriptions; that there is a problem with non-denoting definite descriptions addressed by Russell; that the conclusions of arguments made up of statements whose logical form is captured by PC or LPC are said to follow from the premises iff the argument is valid; that validity is a property of the logical form of arguments; that validity can be defined in terms of accordance with the rules of inference in PC or LPC; that if the premises of an argument are true and if the argument is PC or LPC valid, then the conclusion must be true; that the argument is sound if it is valid and that the premises are true, but it is unsound if it is valid and one or more premise is false; that the rules of valid inference for PC are formed by stating the logical conditions for introducing and eliminating the logical connectives, and that the rules of valid inference for LPC are formed by adding the logical conditions for introducing and eliminating universal and existential quantifiers to PC rules,

any (by teaching y) all other propositions necessary to teach these propositions,

and how to translate ordinary language statements into PC or LPC, and how to perform deductive operations according to PC and LPC rules; to degree n, or

that an inductive argument is not a deductive argument or an enthymeme; that inductive arguments are strong or weak; that a strong inductive argument is an inductive argument in which the conclusion follows from the premises such that it is not probable that the conclusion is false and the premises are true; that a weak inductive argument is an inductive argument in which the conclusion follows from the premises such that it is not probable that the conclusion is true while the premises are true; that the premises of a strong inductive argument provide inductive support for the conclusion; that the elucidation of rules of inductive support is distinct from the justification of induction;[127] that there are some general principles in terms of which rules of inductive support can be developed; that these general principles involve (1) empirical principles (Von Wright on Mill's Methods) and (2) an interpretation of probability (Von Wright, Skyrms, Kyburg); that (1) involves Von Wright's reconstruction of "Mills Methods"; that "presence tables" in terms of 'P' for present and 'A' for absent may be constructed for properties and complex properties (predicates and complex predicates) just as "truth tables" in terms of 'T' and 'F' may be constructed for propositions and complex propositions (statements and complex statements); that a property F is a sufficient condition for a property G iff whenever F is present, G is present; that a property F is a necessary condition for property G iff whenever G is present, F is present; that properties suspected of being necessary or sufficient conditions for a given conditioned property H are called 'possible conditioning properties'; that we may select the necessary or sufficient conditions for conditioned properties from among the possible conditioning properties by a) the direct method of agreement, b) the inverse method of agreement, c) the method of difference, d) the double method of agreement, e) the joint method of agreement and difference; that if the examined possible conditioning properties include the actual conditioning property (either necessary, sufficient or necessary and sufficient condition) then these methods of inductive elimination lead to it with certainty; that a) proceeds to allow the discovery of necessary conditions for a given conditioned property by the elimination of possible necessary conditions by counterexample; possible necessary condition C is eliminated iff conditioned property H is present and C is absent; that b) proceeds to allow the discovery of sufficient conditions for a given conditioned property by the elimination of possible sufficient conditions by counterexample; possible sufficient condition C is eliminated iff C is present and conditioned property H is absent:

[127] They are, however, related questions. If induction is justified, then we may elucidate rules of inductive support using this justification. If we elucidate rules of inductive support by general principles, then we may provide a general justification. However, I shall point out their distinctions.

that c) proceeds to allow the discovery of a particular sufficient condition, given a particular occurrence of a conditioned property, the same as b) except the attempt is to discover which of the properties present in this occurrence of H are sufficient conditions for H; that d) combines a) and b) to allow the discovery of necessary and sufficient conditions for a given conditioned property, that there is a problem with (1); formulating a finite set of possible conditioning properties based upon empirical knowledge; that the nature of $\supset$ is not a problem for this method; that there are inductive arguments that do not have this structure; that such inductive arguments involve statistical concepts and probability; that 2) involves alternative interpretations of 'probability' based on the probability calculus; that some alternative interpretations of 'probability' are interpretations called a) classical, b) empirical, c) logical, d) subjectivist, and e) epistemological; that the probability calculus can be developed to apply to statements, arguments or properties; that the probability calculus states how the probability of a complex statement is related to the probability of its simple constituent statements, that the problem of determining the probability of simple statements is not solved by the probability calculus, like the problem of determining the truth value of simple statements is not solved by PC or LPC; that if a statement is a tautology, then its probability = 1; that if a statement is a contradiction, then its probability = 0, that if two statements are logically equivalent, then they have the same probability; that $P (\sim p) = 1 - P (p)$; that $P (p v q) = P (p) + P (q) - P (p \cdot q)$; that conditional probability, P (q given p) $= P (q \cdot p) : P (p)$; that the rules of inductive logic are the rules that assign probabilities to conclusions; that the probability of a conclusion, given the premises and all relevant available knowledge is a conditional probability of the form P (conclusion given premises · K) which may be calculated P (premises · K · conclusion) : P (premises · K); that rules of inductive logic may be formulated to assign statement probabilities, and then probability calculus rules may be used to calculate the conditional probabilities of inductively reached conclusions, given the premises; that there is no general agreement about how to assign these statement probabilities; that the epistemic probability of a statement is the probability of the statement given all relevant evidence; that there is a problem with 2): the problem of justifying induction, given this account of inductive rules is the inability to justify this initial assignment of statement probabilities: why not some other assignment?; that the classic problem of justifying induction, stated by Hume, arises in many such attempts to formulate inductive rules; that many philosophers have attempted to either solve or dissolve the problem; that this has been done by those offering a view of 'probability';

and (by teaching y) all other propositions necessary to teach these propositions,

and how to perform inductive operations according to 1) and according to 2) to degree n, or

(2) that a statement or set of statements may be unclear; that a statement or set of statements may be unclear because the logical form of the statement or set of statements is unclear; that a statement may be unclear because the extension or the intension of a term in the statement is unclear; that a statement may be unclear because of the equivocal use of a term or terms in the statement; that a statement may be unclear because of the improper vagueness or the ambiguity of terms in the statement; that the use of a term in a statement may be unclear because of the presence of a referentially opaque context; that PC or LPC can be used to capture the alternative logical forms of such statements or sets of statements; that the extension of a term is the entities the term is true of and the intension of a term is the meaning of the term; that equivocation is using the same word in the same context at least twice, at least once with a different intension or extension; that a use-mention confusion involves confusing a word with its extension; that properly vague terms like 'bald' can be used clearly without clearly specifying the extension; that improperly vague terms have no clear intension; that a term in a given context is an ambiguous term when we are unable clearly to determine which of the possible extensions or which of the possible intensions of the term are being

used; that a name may occur referentially in a statement S and not occur referentially in a longer statement formed by embedding S in a psychological context such as 'is aware that', 'believes that', 'says that', 'knows that', doubts that', etc.; that alternative logical forms of a statement or set of statements alternative extensions or intensions of a term, equivocal uses of a term, and vagueness or ambiguity of terms, once cited, must be repaired in so far as possible and given the most plausible interpretation consistent with an author's expressed or implied views; that providing this plausible interpretation involves applying the principle of charity to render deductive arguments valid where possible, to clarify the meaning and extension of terms where possible, to provide univocal uses of terms, to eliminate use-mention confusions, to eliminate the improper vagueness or the ambiguity of terms where possible; that the principle of charity states that the clearest construal of a given statement or set of statements consistent with the author's expressed or implied views must be provided before conceptually significant criticism may occur; that once provided, this plausible interpretation is open to conceptually significant criticism; that conceptually significant criticism involves arguing that a deductively valid argument is unsound and that clarified statements are false; and

all other propositions necessary to teach these, and

how to capture the logical form(s) of a statement; how to recognize the extensions and intensions of terms; how to recognize the equivocal uses of terms; how to recognize use-mention confusions; how to recognize the improper vagueness or the ambiguity of terms; how to recognize an author's expressed or implied views; how to provide plausible interpretations by applying the principle of charity, how to provide conceptually significant criticism; to degree n, or

(3) that to clarify statements using unclear terms, definitions, analyses, or explications can be provided for such terms; that definition is not explication; that it is claimed that there are many types of definitions such as lexical, stipulative and contextual; that there are philosophical problems about the nature of definition; that the

term or phrase to be defined is called the definiendum; that the term or phrase defining the definiendum is called the definiens; that providing necessary and sufficient conditions (as a definiens for a definiendum) provides a definition of the definiendum; that some definitions may be evaluated by considering counterexamples; that counter-examples are examples illustrating that a given definition or claim is false by showing that the definiens and the definiendum are not extensionally equivalent; that other types of definitions may be evaluated in other ways; that an explication is the transformation of an inexact, prescientific concept called the explicandum into a new, exact concept called the explicatum; that the explicandum cannot be explained in exact terms, but can be made clear by informal explanation and example; that if the explicandum cannot be made clear in this way, we might consider giving up the attempt to explicate the term in question; that there is an extensional overlap to be preserved between the explicandum and the explicatum; that the decision to adopt an explicatum is based on considerations other than prior use; that an explicatum may not be evaluated in terms of synonomies or even degree of extensional overlap between explicandum and explicatum; that the explicatum may be evaluated according to the following explicit criteria: 1) the explicatum must be similar to the explicandum in that there must be significant extensional overlap, however, in a given context for a given purpose, the best explicatum need not be the one with the most extensional overlap with the explicandum, 2) the explicatum must be a concept that can be defined in a clear, precise manner, and it must have an extension, 3) the explicatum must be theoretically fruitful as determined by an appeal to context and to purpose, and 4) the explicatum should be as simple as conditions 1) through 3) allow; that in an explication of 'fish', 'fish' is an example of an explicandum and 'member of the class Piscus' is an example of an explicatum; that a proposed clarification of a statement may be evaluated in terms of its relation to the principle of charity by asking: is this the clearest construal of a given statement?; that asking this involves asking if the clarification clearly exhibits the logical form of the statement, if the clarification clarifies the intension and extension of terms where possible, if the clarification provides univocal uses of terms eliminating the improper vagueness or the ambiguity of terms where possible, and if the clarification is consistent with the author's expressed or implied view, and

all other propositions necessary to teach these propositions, and

how to recognize different types of definitions, how to formulate counterexamples; how to recognize and evaluate a proposed explicatum; how to recognize and evaluate a proposed clarification of a statement: to degree n, or

(4) that providing deductive support for a given statement S involves providing the suppressed premise of an enthymeme with the given statement S as the conclusion, or providing true premises in a valid deductive argument form with the given statement S as the conclusion; that deductive arguments offered in ordinary language are often enthymemes; that enthymemes are deductive arguments with one or more unstated premise called a suppressed premise; that capturing the logical form of an enthymeme by PC or LPC symbols helps in the discovery of the suppressed premise or premises; that the suppressed premise must be stated to put the enthymeme in deductively valid form; that given a deductively valid form, the argument may be evaluated for soundness; that non-enthymematic deductive arguments are evaluated according to the rules of PC or LPC for validity; that given a deductively valid form, the argument may be evaluated for soundness; that providing inductive support for a given statement S can involve two alternative methods; that 1) if S is a statement about the relation of a conditioning property to a conditioned property, then providing inductive support for S involves providing possible conditioning properties and supporting the relation of the conditioning property to the conditioned property stated in S (the necessary, the sufficient, or the necessary and sufficient condition) by applying a) the direct method of agreement, b) the inverse method of agreement, c) the method of difference, d) the double method of agreement, or e) the joint method of agreement and difference; that 2) if S is a

statement not of this form, then providing inductive support for S involves providing a statement of evidence E for S such that E is true and such that P (S given E) $>$ P (S); that inductive support for statements of form 1) is evaluated by applying methods a) or b) or c) or d) or e) to test for the presence and absence of possible conditioning properties to determine the relations among the conditioning property and the conditioned property; that when providing inductive support for statements S of form 2), strong inductive arguments with a high degree of conditional probability may be said to support S and weak inductive arguments with a low degree of conditional probability may be said to fail to support S, and

all other propositions necessary to teach these propositions, and

how to provide the suppressed premise or premises of an enthymeme, how to provide true premises in a valid deductive form to support S; how to evaluate a deductively valid argument for soundness; how to provide inductive support for 1); how to provide inductive support for 2); how to evaluate inductive support for 1) and how to evaluate inductive support for 2); to degree n, or

(5) that a fallacy is an error in reasoning that has a certain psychological persuasiveness; that fallacies are often used when the goal of an argument is simply to persuade opponents or an audience that the conclusion is true or highly probable; that we may define a fallacy in terms of an argument; that f is a fallacious argument iff f is invalid and f is not an inductive argument and f's conclusion is reached by an error in reasoning r that is psychologically persuasive; that r is a psychologically persuasive reason for conclusion c iff $\forall x$ (x is a person and x is persuaded by r to accept c); that this broad definition of 'psychologically persuasive reason' includes valid PC and LPC arguments, strong inductive arguments, as well as errors in reasoning; that the interesting feature of fallacies is that they involve errors in reasoning that are also psychologically persuasive: that so construed,

that are also psychologically persuasive, given this broad notion; that intuitively, blatant contradictions are not psychologically persuasive but that contradictions buried in complexity of argument may be psychologically persuasive; that some violations of PC rules that are psychologically persuasive have been given names; that denying the antecedent involves an error of the form $p \supset q$, $\sim p$, therefore $\sim Q$; that affirming the consequent involves an error of the form $p \supset q$, q, therefore p; that the fallacy of conjunction involves an error of the form $\sim (p \cdot q)$, $\sim p$, therefore $\sim q$; that formal fallacies can be exposed by capturing the logical form of statements and applying PC or LPC rules; 2) that fallacies of ambiguity involve errors of reasoning resulting from ignoring the ambiguities of ordinary language like ambiguous words, phrases, or sentences; that specific fallacies of this type are equivocation, amphiboly, accent, composition and division; that equivocation involves the ambiguity of a word or phrase; that the fallacy of equivocation is committed when a word or phrase having more than one extension or intension is used by appealing to distinct extensions or intensions in the same context; that amphiboly involves the ambiguity of grammatical constructions; that the fallacy of amphiboly is committed when a conclusion is invalidly inferred from a premise because of the premises ambiguous grammatical structure; that accent also involves the ambiguity of grammatical construction; that the fallacy of accent is committed when a conclusion in invalidly inferred from a premise because of placing unwarranted emphasis on certain words in the premise; that composition and division both involve inattention to language attributing properties to a part, or to a member in a class, and properties to a whole or to a class; that the fallacy of composition is committed when one argues that if the parts of a complex object or the members of a class have a property, then the complex object or the class has the property; that the fallacy of division is committed when one argues that if a complex object or class has a property, the the parts of the complex object or class have this property; 3) that fallacies of relevance involve errors in reasoning resulting from no rational connection between premises and conclusions: that the evidence stated in the premises is irrelevant to the truth or probability of the conclusion; that specific fallacies of this type are ad baculum, ad misericordian, ad hominum, ad vercandiam, ad populum, ad ignorantium, false cause, ignoring the question, complex questions, begging the question; that ad baculum involves the most blatant example of premises that do nothing to prove that a conclusion is true, or probable; that such arguments offer threats as premises intended to coerce one to accept the conclusion; that ad misericordiam arguments involve offering claims that harmful consequences or unhappiness for others will result, as premises, unless we accept a given conclusion; that ad hominum arguments involve offering claims about some person as premises in an argument against a conclusion he supports; that there are two forms of this fallacy; abusive and circumstantial; that the abusive form of the fallacy involves directly attacking the claim a man makes by directly attacking the man; that the circumstantial form of the fallacy involves offering as premises reasons why, by virtue of certain personal circumstances, one should accept or reject a particular conclusion; that ad verundiam arguments involve an appeal to an unsuitable authority as premises to support a given conclusion; that not all appeals to authority are fallacious, for example that Linus Pauling says he believes that Vitimin C affects the body's resistance to invading viruses counts as evidence for the claim since Pauling is a noted biochemist; that an example of the fallacious appeal to authority is an example which appeals to a given authority in a field to support a claim about something in an unrelated field; that ad populum arguments involve an appeal to generally accepted beliefs, or majority opinion as premises to support a given conclusion that is not about accepted beliefs or people's opinions; that popular opinion is used as an authority; that ad ignorantiam arguments involve offering appeals to ignorance as premises to support a given conclusion; that the fallacy involves arguing that a certain conclusion is true or probable because either it has not been disproved or one does not know how it could be disproved; that false cause arguments involve an appeal to premises stating that event A came before result C to support the conclusion that A caused C; that ignoring the question involves offering an argument in support of some conclusion that is totally irrelevant to the question at hand; that complex questions involves supposing that a simple yes or no answer to a question containing a hidden question is sufficient evidence for a conclusion based on this answer and the hidden question; that begging the question involves assuming as a premise the conclusion to be proved by the argument; that the premise often simply says in different words what the conclusions affirm; and

all other propositions necessary to teach these propositions, and

how to recognize informal fallacies; how to evaluate arguments contining informal fallacies; to degree n, or

how to engage in complex activities involving combinations of the skills involved in (1), (2), (3), (4) and (5) to degree n.

C.4, then, exhaustively answers the question "How can correct critical thinking be successfully taught?" by providing the specific propositions and the specific skills which, when successfully taught to degree n, are sufficient to teach correct critical thinking to degree N. The degree N of critical thinking is, again, like in D.11, a function of the degree n of each of (1), (2), (3), (4) and (5), or any combinations.

However, suppose that the recalcitrant educator insists on pursuing the first form of the question "How can critical thinking be taught?" and demands to be provided with some method for successfully teaching C.4 (1), (2), (3), (4) and (5). To be provided with some such method is to be provided with a method that satisfies the second disjunct of D.20, the definition for engaging in successfully teaching that, and that satisfies the second disjunct of D.21, the definition for engaging in successfully teaching how.

First, consider the second disjunct of D.20. To satisfy this disjunct, any M must get y to come to believe that x believes that Ø at t; y to come to believe that Ø at t+1; y to come to believe that x believes x is justified in believing that Ø at t; and y to come to believe that y is justified in believing that Ø at t+1. Secondly, consider the second disjunct of D.21. To satisfy this disjunct, any method must allow x to provide a model for y to Ø between t-1 and t+1, where x provides a model for y to Ø iff x intends or some z intends that x make evident the applications of the rules according to which someone can do Ø, and the method must get y to Ø at t+1. Any method must satisfy these disjuncts, otherwise it cannot be said to contribute to successful teaching.

However, the choice of a method to satisfy these disjuncts will depend on at least five contingent factors. The first factor is the personality and individual strengths of the teacher. For example, some teachers are patient, outgoing, and good at asking leading questions, while other teachers are more intolerant, reserved, good at lecturing and good at answering questions. The second factor is the size and length of the class. For example, asking leading questions may work well in a small class with sufficient time, but work poorly in a filled lecture hall with insufficient time. The third factor is the background and ability of the students. For example, lecturing and answering questions may work well for a class with bright students with a sufficient background who are unafraid to ask question, however, it may not work well for slower students without sufficient background who are afraid to ask questions. The fourth factor is the degree n to which C.4 (1), (2), (3), (4) and (5) are to be successfully taught. This determines the degree N to which correct critical thinking is to be successfully taught, and by D.12, determine the degree N of critical intelligence to be taught. For example, one may expect successfully to teach second graders correct critical thinking by successfully teaching some of C.4 (5) to degree n, yet this will be a very low degree N of critical thinking. One may approach college freshmen with the expectation of successfully teaching all of C.4 to degree n, and this will be a much higher degree N of critical thinking, and a correspondingly higher degree N of critical intelligence. Of course, we may also modify C.4 itself to add more advanced skills such as modal logic and thereby change the range of degree N of critical thinking in the scope of the proposed curriculum.) Therefore, such alternative curricula also affect the degree N to which critical intelligence is taught.

The fifth factor is the particular combination of the first four factors that obtains.[128] For example, an intolerant teacher good at lecturing with a large class of bright students may adopt a different method than a patient teacher good at asking leading questions with a small class of slow students, even though both teachers are teaching the same curriculum, for example, C.4. They may also be said to be teaching (1), (2), (3), (4) and (5) of C.4 to a different degree n. Therefore, given these five contingent variable factors, it is unfruitful to provide a single method for successfully teaching C.4 (1), (2), (3), (4) and (5): there simply is no single method. In the absence of a particular set of these five factors, it must be sufficient to show that to be successful, any such method must satisfy the second disjunct of D.20 and the second disjunct of D.21.

[128] Superficially there appear to be 5^5 possible combinations of these factors. However, there are many sub-factors under each of the five factors I mention, and the combinations of these sub-factors must also be taken into account. Let n1 through n5 represent the number of these sub-factors under factors 1 through 5. The possible combinations of these factors is $(5 + n1 + n2 + n3 + n4 + n5)^{(5 + n1 + n2 + n3 + n4 + n5)}$. A large number!

With the question "How can correct critical thinking be successfully taught?" answered in terms of C.4 and the second disjuncts of D.20 and D.21, we have answered the question "How can critical intelligence be taught?" We are now in a position to provide a model for successfully teaching correct critical thinking, and thereby for successfully teaching critical intelligence, as an appendix.

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APPENDIX

A MODEL FOR TEACHING CRITICAL INTELLIGENCE

Applying D.21, x successfully engages in teaching y how to teach critical intelligence by successfully engaging in teaching y how to teach correct critical thinking. To do this, according to the second disjunct of D.21, is, among other things, to provide a model for y successfully to teach correct critical thinking. In this Appendix, I shall provide such a model designed to teach y how to teach correct critical thinking in terms of C.4, the successful teaching of which is a sufficient condition for the successful teaching of critical thinking. As I have shown, this model must not only satisfy the second disjunct of D.20 and D.21, but must also specify a specific context in terms of at least five contingent factors which in turn may help determine a method for successfully teaching correct critical thinking.

In Part I, I shall specify and discuss five particular contingent factors to provide a specific context for this model and to provide a method for teaching C.4. To do so, I shall critically consider a model presented by Matthew Lipman designed to teach y how to teach what Lipman calls "philosophical thinking." I shall first consider the goals of the curriculum Lipman provides and argue that while Lipman's curriculum may, like C.4, be sufficient to teach correct critical thinking, there is no necessary connection between engaging in philosophy and engaging in correct critical thinking. I shall conclude that critical thinking may more properly be viewed as an interdisciplinary activity that need not be bound to any particular subject.

I shall secondly consider the method Lipman provides to teach what he calls "philosophical thinking." I shall argue that Lipman confuses the consequences of initiating teaching from information or interests familiar to students with the consequences of initiating teaching from a limited point of view, and that initiating teaching from information or interests familiar to a student is not a sufficient condition for developing harmful pedagogical consequences. I shall conclude that Lipman does not offer a convincing pedagogical reason to reject the method of initiating teaching from information or interests familiar to students.

I shall thirdly draw two consequences from this consideration of Lipman's model that are important for the specification of the model I shall provide for teaching y how to teach correct critical thinking. First, I shall argue that teaching correct critical thinking as a curriculum like C.4 need not be bound to one subject; its teaching can be accomplished by considering alternative subjects to fit particular educational situations. I shall specify such a subject and such an educational situation in terms of factors 1, 2, and 3. Secondly, I shall argue that teaching correct critical thinking, as defined in D.11, need not be bound by any one particular curriculum like Lipman's or like C.4 to any one particular range of degree N of correct critical thinking. Given C.4, I shall specify the range of degree N and in turn specify factors 4 and 5.

I shall fourthly point out that the model I shall provide will satisfy the second disjuncts of D.20 and D.21; it will satisfy D.20 by presenting and justifying material, and it will satisfy D.21 by presenting models and student-involving exercises.

Given this particular educational context, specified in Part I, I shall then clearly specify this model in Part II. First I shall state a) the nature of the model, b) the curriculum of the model, c) the method of initiating teaching in the model, d) the subject for critical thinking in the model, and e) the specific organization of the model. Regarding a), I shall distinguish a textbook to be read by students from an instructional model to be followed by teachers. I shall note that the latter is sufficient for my purposes here. Regarding b), I shall refer to C.4, a curriculum the teaching of which is sufficient to teach correct critical thinking. Regarding c), I shall point out the benefits of adopting the method of initiating teaching from information or interests familiar to students for this instructional model. I shall explain the method in terms of presenting the material, presenting models, and presenting student-involving exercises. Regarding d), I shall provide a bibliography of pseudo-scientific works offering explanations of various phenomena which are to be the subjects for critical thinking in the model. Regarding e), I shall explain the division of this instructional model into five sections.

Secondly, I shall present the instructional model for the development of critical intelligence outlined as follows:

Introduction: Arguments and Their Evaluation

Section One: Deductive Arguments and Their Evaluation

Section Two: Inductive Arguments and Their Evaluation

Section Three: Clarifying Arguments

Section Four: Providing Arguments

Section Five: Informal Fallacies In Arguments

PART I

A CONTEXT FOR THE MODEL

Matthew Lipman is actively engaged in designing curricula to teach children what he calls "philosophical thinking." Lipman, the Director for the Institute for the Advancement of Philosophy for Children, has written a book, Harry Stottlemeier's Discovery, designed as a basic teaching resource to develop "philosophical thinking" among 5th and 6th grade students.[129] In a review, Gerald L. Gutek describes Harry Stottlemeier's Discovery as

> "A novel of 96 pages, divided into 17 short chapters. Each chapter reports a discussion that takes place among a group of children, among whom the chief character is Harry Stottlemeier . . . the book is never abstract and never pedantic. Each discussion brings philosophical thinking to bear on the logical and ethical concerns of the children."[130]

[129] Matthew Lipman, Harry Stottlemeier's Discovery, published for the Insititue for the Advancement of Philosophy for Children, Montclair State College (Upper Montclair, NJ 07043), by Universal Diversified Services, Inc. (Caldwell, NJ, 07006), 1975. Lipman and Ann Margaret Sharp also provide an instructor's manual, Instruction Manual to Accompany Harry Stottlemeier's Discovery , same publisher, 1975. I shall make reference only to this instructor's manual.

[130] Gerald L. Gutek, "Philosophy in the Elementary School: A Growing Movement?," Phi Delta Kappan (April 1976).

Gutek also states its objective in the elementary school curriculum and points to the nature of "philosophical thinking." He claims that

> "Although attempts are made to teach children to think about history, mathematics, science, and many other subjects, little in the child's education introduces him to the nature and process of his own thinking and to the thinking of others . . . the most efficacious way of examining thinking and valuing is to use the philosophical tools of ethics and logic."[131]

Lipman's curriculum can be construed as attempting to teach critical thinking by attempting to teach what he calls "philosophical thinking."

That Lipman is concerned to provide a curriculum to teach critical thinking can be seen by considering his discussion of "philosophical thinking" in the Instructional Manual to Accompany Harry Stottlemeier's Discovery. Critical thinking is a component of what he calls "philosophical thinking." He states that

> "A course in philosophical thinking, whether for children or for adults, can never be guilty of serving as a means for implanting the teacher's values in the uncritical minds of the children in the classroom . . . when students have reached a point in the

[131] Gerald L. Gutek, "Philosophy in the Elementary School: A Growing Movement?," Phi Delta Kappan, (April 1976).

> development of their critical abilities such that they can deal objectively with the teacher's opinions without feeling coerced by them, and if the students desire to know what the teacher's opinion is, no great harm would likely result from his explaining just what he thinks."[132]

Furthermore, the development of critical reasoning abilities, as a component of philosophical thinking, is a necessary component. According to Lipman,

> "Indeed, it is only by mastering the tools of reasoning which constitute the backbone of our explorations in many areas through the chapters of Harry Stottlemeier's Discovery that we can master the art of philosophical thinking."[133]

This development of a critical mind through the development of critical reasoning abilities as the "backbone of philosophical thinking" is provided for in Lipman's curriculum by at least five of the six specific goals listed for this course in philosophical thinking. He lists these goals as

> "The improvement of reasoning abilities, including perceptual influences, logical inference from evidence,

[132] Gerald L. Gutek, "Philosophy in the Elementary School: A Growing Movement?," Phi Delta Kappan (April 1976), pp. 3-4.

[133] Gerald L. Gutek, "Philosophy in the Elementary School: A Growing Movement?," Phi Delta Kappan (April 1976), p. 1.

> the ability to discover alternatives, impartiality, consistency, the feasibility of giving reasons for beliefs, comprehensiveness and situations."[134]

It is clear from the discussion of these goals that having these abilities is a sufficient condition for having the ability to engage correctly in critical thinking.

However, while critical thinking is a necessary component of Lipman's notion of "philosophical thinking," "philosophical thinking" includes abilities other than critical thinking abilities. These abilities are creative thinking abilities and abilities to recognize distinctively philosophical problems. Lipman argues that

> "It is not enough to challenge (the student) to develop his logical ability alone, although such development is certainly necessary. But his growth (in philosophical thinking) also depends upon stimulating his inventiveness and creativity."[135]

[134] Gerald L. Gutek, "Philosophy in the Elementary School: A Growing Movement?," Phi Delta Kappan (April 1976), pp. 4, 6. The discussion is provided from pages 6 to 11. I shall grant that as Lipman describes them, having these abilities and being able to engage in them correctly is a sufficient condition for having the ability to engage correctly in critical thinking.

[135] Gerald L. Gutek, "Philosophy in the Elementary School: A Growing Movement?," Phi Delta Kappan (April 1976), p. 5

Lipman is also concerned to teach an ability to recognize distinctively philosophical problems as they arise among the children's own concerns.

> "They deal with the epistemological problem of the nature of the mind and ideas; they use language analysis in examining definitions of objects and activities; they deal with differences of kind and degree; they disentangle fact from opinion by pursuing (moral) problems that arise from their own ideas of politics, race, and civil rights; they explore methods of inquiry.[136]

Therefore, while "philosophical thinking" as described by Lipman includes critical thinking as a necessary component, "philosophical thinking" is not the same as critical thinking. Granting that teaching "philosophical thinking" is a sufficient condition for teaching critical thinking, teaching critical thinking is not a sufficient condition for teaching "philosophical thinking" as described by Lipman.

Indeed, there is a pedagogical danger in confusing "philosophical thinking" with critical thinking. Both

[136] Gerald L. Guteck, "Philosophy in the Elementary School: A Growing Movement?," Phi Delta Kappan (April 1976).

Lipman and Clyde Evans come dangerously close to teaching that critical thinking is the unique province of philosophy.[137] For example, Lipman talks about "philosophical thinking" and Evans talks about "the philosophical method," seemingly implying that critical thinking and creative thinking as components of "philosophical thinking" and "the philosophical method" are the unique province of philosophy, and uniquely applied to philosophical problems. The pedagogical danger is that students will fail to see the relation of critical thinking, or creative thinking as basic reasoning skills to other academic disciplines and to problems that are not philosophical problems.

Critical thinking is not an activity that is unique to any one academic discipline or professional field, but is an activity that cuts across many academic disciplines, professional fields and everyday concerns. There is no necessary connection between engaging in philosophy and engaging in correct critical thinking. Artists, physicists, political scientists, sociologists, historians, psychologists, mathematicians, clerks, physicians, and philosophers each may be called upon to engage in some

[137] See Clyde Evans, "Philosophy With Children: Some Experiences and Some Reflections," Metaphilosophy, Vol. 7, No. 1 (Jan. 1976), pp. 53-69.

degree N of critical thinking when evaluating particular arguments relevant to their respective fields. Nor is critical thinking limited to such narrowly conceived academic or professional concerns. Consumers, advertisers, voters, politicians, PTA members, boards of education members, husbands, wives and children each may also be called upon to engage in some degree N of critical thinking when evaluating particular arguments. It is in this sense, then, that critical thinking may be said to be an interdisciplinary activity.[138]

Lipman also provides a basis for his method to teach philosophical thinking that we may consider as a possible basis for a method to teach critical thinking. Lipman states that

> "We should begin with the large outlines of a subject, and gradually move towards specialized areas. Begin with large brushstrokes, and then paint in details."[139]

By "subject" he seems to mean "academic discipline". For example, he mentions history, economics, and sociology.

[138] Certainly the same could be said for creative thinking. However, the concern here is limited to what I have called critical thinking.

[139] Matthew Lipman, Instruction Manual to Accompany Harry Stottlemeier's Discovery, p. 1-1.

Furthermore, he argues that

> "We've been told that we should start with what is familiar to the child and then work outwards to larger frames of reference, from himself to his family, to the community in which he lives, to his state, his nation and the world. There is much to recommend in this method - teaching should begin where the child is; the only question is, where the devil is he? On the other hand, what is chiefly wrong with the method is that it gives him an egocentric perspective which a lifetime of reeducation may not be able to overcome."[140]

Lipman seems to argue, given that we know what is familiar to, or of interest to a child, that if we begin our teaching from this point, then it follows that this will develop in the child a harmful egocentric perspective. Therefore, we must not begin teaching from information or interests familiar to a child, but instead, begin with the large outlines of a subject, and gradually move toward specialized areas.

Lipman argues that

> "We stress American history, then European history, then World history. Maybe not in that order, but the emphasis is clear enough throughout in our point of view. We seldom ask what the British point of view is regarding the American Revolution, or the Japanese point of view in World War II, etc. But every history is a history from some perspective, and we cannot

[140] Matthew Lipman, Instruction Manual to Accompany Harry Stottlemeier's Discovery, p. 1-1.

> saturate the child with the belief that ours is the true and only perspective without running the risk of his growing up a bigot."141

However, Lipman seems to confuse the consequences of initiating teaching from information or interests familiar to a child with the consequences of initiating teaching from a limited point of view. Clearly, these have distinct consequences.

Initiating teaching from information or interests familiar to a child is not a sufficient condition for developing what Lipman calls a "harmful egocentric perspective." This does not necessarily result in teaching from a limited point of view.

Consider Lipman's example of teaching history. Suppose that we initiate the teaching of history by eliciting a child's own family history. This is certainly familiar to the child. We may then compare one child's family history with another child's family history, and note relationships among families; for example, that the two children are friends. However, we may also immediately teach that a history of a family is a history from a given point of view.

[141] Matthew Lipman, Instruction Manual to Accompany Harry Stottlemeier's Discovery, p. 1-1.

For example, we might ask a child if he ever fought with his friend; then ask what his friend's brother's reaction to the fight; then ask what was his own brother's reaction, etc. We might thereby elicit alternative accounts of the same fight from each family's point of view. We are then able, by analogy, to discuss American, European, or World history from alternative points of view, yet we initiate our teaching from information or interests familiar to a child. Therefore, initiating our teaching from this point of view does not result in teaching from a limited point of view.

This approach may also introduce the child to other points of view regarding his own personal history, and, therefore, will not necessarily develop in the child what Lipman calls "a harmful egocentric perspective." Therefore, initiating teaching from information or interests familiar to a student is neither the same as teaching from a limited point of view, nor a sufficient condition for developing this harmful egocentric perspective. Therefore, Lipman does not provide a convincing reason to reject the method of initiating teaching from information or interests familiar to students and to adopt the method in initiating teaching from the large outlines of a subject.

This consideration of Lipman's model for teaching "philosophical thinking" has shown first, that critical thinking is not the exclusive concern of any one subject and it may, for this reason, be said to be an interdisciplinary activity, and second, that the method of initiating teaching from information or interests familiar to students need not result in pedagogically objectionable results. This, in turn, allows us to draw two important consequences for the model I shall provide for teaching y how to teach correct critical thinking.

The first consequence is that teaching correct critical thinking as a curriculum like C.4 need not be bound to one subject, but could be accomplished by considering alternative subjects to fit a particular educational situation. The way successfully to teach critical thinking is the way that gives the student something to think critically about. This way to teach critical thinking may, therefore, appeal to many alternative subjects. There is no need to limit the subject to philosophy since critical thinking is not a uniquely "philosophical tool." The second consequence is that we may adopt the method of initiating the teaching of critical thinking from information or interests familiar to students and still avoid pedagogically objectionable results, and, therefore, we may choose any subject that is of interest or familiar to students to initiate teaching correct critical thinking.

For example, given these two consequences, C.4 could be taught by using the subject of the natural sciences as a subject that gives the students something to think critically about, given a group of students interested in, or familiar with the natural sciences. Or C.4 should be taught by using the subjects of philosophy, sociology, psychology, history, or mathematics, as subjects that give the students something to think critically about, given a group of students interested in or familiar with philosophy, sociology, psychology, history, or mathematics. Or C.4 could also be taught by using more general subject matter, for example, the subject of popular explanations of UFO's, ship and plane disappearances, and faith healers as a subject that gives the students something to think critically about, given a group of students intersted in or familiar with such popular explanations.[142]

These consequences also allow us to state grounds for the selection of a subject for students to think critically about, by stating grounds for selecting a subject that is familiar or of interest to students who are to be taught C.4. It is pedagogically desirable to select a subject

[142] In this period of history, such popular explanations include Erich VonDäniken's _Chariot of the Gods_, Charles Berlitz' _The Bermuda Triange_, Ralph and Judy Blum's _Beyond Earth: Man's Contact With UFO's_, Fuller's _Arigo: Surgeon of the Rusty Knife_, etc., but they are rapidly replaced by others of the same _genre_.

that is familiar or of interest to students to think critically about because in teaching C.4, one must focus on teaching critical thinking, and not focus simply on teaching a particular subject which students are to think critically about. For example, in using the subjects of the natural sciences, philosophy, sociology, psychology, history, mathematics or popular explanations as subjects that give the students something to think critically about, one is not focusing on teaching these subjects. Students, then, will not be faced with difficult subject matter that is either uninteresting to them or new to them and will instead simply be faced with a curriculum like C.4 and some familiar subject matter that they may begin to think critically about.

Therefore, the choice of a subject to think critically about and thereby to present C.4, depends upon the students major fields of interest or familiarity. This is often easier to determine at the college level than at the elementary level. Therefore, for the purposes of this model, I shall stipulate that the students are interested in the natural sciences and at least vaguely familiar with current popular pseudo-scientific explanations of various phenomenon.

We are now in a position to stipulate the first contingent factor to further specify the context for this model: the personality and background of the teacher. The model is designed for college level students with some interest in the natural sciences. Therefore, the teacher must have the background and ability to successfully teach them correct critical thinking in terms of C.4, given the subject of current popular pseudo-scientific explanations of various phenomena to think critically about, and given the student's interest in the natural sciences. For the purpose of this model, it is desirable that the teacher know some natural science, and have worked through (in terms of C.4) the current popular pseudo-scientific explanations of various phenomena which are to be the subject for critical thinking. Furthermore, given C.4, it is desirable that the teacher know first order logic, have the ability to work in a suitably specified first order object language with rules or axioms, know that consistency, completeness and soundness can be proved in a meta-language, and have a basic familiarity with non-deductive inference, and the associated problems with non-deductive inference. It is desirable that the teacher also know how to engage in the skills listed in D.11, and be relatively comfortable lecturing and answering questions.

The second contingent factor is class size and length and the third contingent factor is the background and ability of the students. For the purposes of this model, the class will be limited to no more than 24 students meeting at least 3 hours per week for at least two full semesters. Also for the purpose of this model, the students will be limited to college students above average in both intelligence and motivation, with some interest in the natural sciences and some familiarity with current popular pseudo-scientific explanations of various phenomena.

However, it is useful to point out that critical thinking as defined by D.11 need not be bound by any one particular curriculum like C.4 in any one particular context to what we may call any one particular range of degree N of critical thinking. Intuitively, the range of degree N can be raised or lowered according to the needs of a particular academic discipline, professional field, or to the particular needs of dealing with everyday concerns in a particular educational context. It can also be raised or lowered according to the background and ability of the teacher, and the age, background, interest and ability of the students.

Intuitively, we can see that the range of degree N may be raised or lowered by proposing alternative curricula such that successfully teaching some curriculum is sufficient successfully to teach correct critical thinking, but to a higher degree N than C.4. Therefore, for educational situations unlike the one specified for the purposes of this model, alternative curricula may be provided to teach correct critical thinking to a higher or lower degree N. For example, C.4 is a curriculum suitable for bright college level students, but not suitable for 5th and 6th grade students. Similarily, Lipman's curriculum is suitable for 5th and 6th grade students, but not suitable for bright college level students.

Given C.4, however, the fourth contingent factor to stipulate is the degree to which (1), (2), (3), (4) and (5) are to be taught successfully.[143] Intuitively, for the purposes of this model, I shall require their successful teaching to a medium degree n, which will in turn result in successfully teaching a medium high degree N of critical thinking or critical intelligence. For example, while teaching (1) of C.4 involves teaching LPC, it does not involve teaching modal logic. If it did, then the degree N of critical thinking taught by C.4 may be higher, given the successful teaching of (1) plus modal logic to a medium degree n. Therefore, C.4 is designed to allow for increases

[143] Or the degree n to which any component of any alternative curriculum which is designed successfully to teach correct critical thinking to a higher or lower degree N, is to be taught successfully.

in the degree N of critical thinking by providing a framework to incorporate additional skills, that fit into (1), (2), (3), (4) or (5) that are learned in logic, science, philosophy, math, literature or religion courses.

In this sense, then, a curriculum like C.4 provides what may be called an interdisciplinary framework to reject or to evaluate and to incorporate basic reasoning skills acquired in specific academic disciplines, where such rejection maintains the degree N of critical thinking and where such incorporation increases the degree N of critical thinking. In this way, then, we may account for increasing the degree N of critical thinking by so incorporating basic reasoning skills acquired in specific academic disciplines. I shall call this increasing of the degree N the development of critical intelligence. Therefore, successfully teaching correct critical thinking, thereby teaching critical intelligence, provides the basic framework which, in turn, allows for its further development through exposure to various academic disciplines.

The fifth contingent factor serves to summarize the first four contingent factors specifying the educational context of this model for teaching y how successfully to teach correct critical thinking. The teacher is required to have some background and interest in the natural sciences, and to have worked through the current popular pseudo-scientific explanations of various phenomena which are to be the subjects for critical thinking. The teacher is also required to know both deductive and non-deductive logic, and to know how to engage in the skills listed in D.11. The students, grouped in classes of no more than 25, meeting at least three hours per week for two semesters, are required to be college level students, above average in both intelligence and motivation, with some interest in the natural sciences and some familiarity with current popular pseudo-scientific explanations of various phenomenon. The components of C.4 are required to be taught successfully to a medium degree n, which will in turn result in successfully teaching critical thinking, or critical intelligence, to a medium high degree N.

Given this educational context for this model, and given this method to initiate teaching from information or interests familiar to the students, we must see how the second disjucnts of D.20 and D.21 are to be satisfied by the model. First, the model must satisfy the second disjunct of D.20 simply by presenting and justifying the propositions to be taught. This may also be done by showing the student the implications of these propositions for his own areas of interest and familiarity and the implications of assuming that they are false for his own areas of interest and familiarity. Secondly, the model may satisfy the second disjunct of D.21 simply by presenting models (as defined by D.21) and by presenting student-involving exercises. These student-involving exercises provide evidence both to the teacher and to the student that the student does or does not know how to engage in a particular activity by giving the student the chance actually to engage in the activity. In this way, then, this model will satisfy the second disjuncts of D.20 and D.21.

PART II

AN INSTRUCTIONAL MODEL FOR THE DEVELOPMENT OF CRITICAL INTELLIGENCE

This model is not designed to be a textbook read by students. It is designed to be an instructional model to show a teacher how someone might successfully teach correct critical thinking, in terms of C.4, in the educational context stipulated in Part I. This is sufficient to show a teacher how someone might successfully teach correct critical thinking.

As discussed and stipulated in Part I, the model uses the method of initiating teaching from information or interests familiar to students. This method has three related practical benefits for this model. First, presenting the material in C.4 in terms of a familiar, or interesting subject matter may help the students to learn C.4 without the the unnecessary confusion of unrelated examples. Secondly, this may help them to expose confusions and misconceptions at an early stage in their instruction since they supposedly feel some confidence in dealing with this topic. Thirdly, this may help the students to become interested in the student-involving exercises. Interest in a problem is a necessary condition for active participation in its solution. Likewise, interest in a particular subject is necessary to involve students in a more hard-headed intellectual approach to the subject. This method allows the teacher to presuppose such interest while providing the intellectual tools to direct it critically. As Albert Einstein remarked about such interest in a subject, "It is a very grave mistake to think that the enjoyment of seeing and searching can be promoted by means of coercion and sense of duty."

In this way, the method in initiating teaching from information or interests familiar to students uses student interests practically to apply the content of C.4. This may ideally eliminate the need for teacher developed student interest, but it does not eliminate the need for teacher directed student interest. In this model, for example, students interested in UFO's may, in fact, believe that UFO's are best explained as an extraterrestrial visitors. This, however, immediately allows the teacher to consider the grounds for such a belief and the standards for an acceptable explanation. This method then is designed to save time and allow for the immediate application of C.4 to arguments in which the students have some interest.

As stipulated in Part I, the subject matter to be critically thought about for the purposes of this model is to be current popular pseudo-scientific explanations for various phenomena. The annotated bibliography is as follows:

1. Charles Berlitz, The Bermuda Triangle, Avon Books, New York, 1974. (A suggestive chronicle of supposedly mysterious and unnatural disappearances of planes and ships in a section of ocean without fixed boundaries.)

2. Ralph and Judy Blum, Beyond Earth: Man's Contact with UFO's, Bantam Books, New York, 1974. (A suggestive chronicle explaining individual encounters with UFO's as encounters with extraterrestrial visitors.)

3. John G. Fuller, Arigo: Surgeon of the Rusty Knife, Pocket Books, New York, 1975. (A suggestive chronicle of the supposedly miraculous healing power of a Brazilian hillbilly.)

4. Martin Gardner, Fads and Fallacies in the Name of Science: The Curious Theories of Modern Pseudo-Scientists and the Strange Amusing and Alarming Cults that Surround Them: A Study in Human Gullibility, Dover, New York, 1957. (An exhaustive exposition of many different pseudo-scientific explanations in many different areas of science.)

5. Phillip J. Klass, UFO's Explained, Random House, New York, 1974. (A thoughtful collection of natural explanations for UFO's).

6. Lawrence D. Kusche, The Bermuda Triangle Mystery: Solved, Warner Books, New York, 1975. (A thoughtful collection of natural explanations for missing planes and ships.)

7. Erich VonDäniken, Chariots of the Gods?: Unsolved Mysteries of the Past, Bantam Books, New York, 1971. (A suggestive chronicle purporting to explain various architectural and archeological data, supposedly unexplainable, by appealing to the actions of extraterrestrial visitors.)

Books 1, 2, 3, 4 and 7 may be assigned as books to be read by the class, and are to provide the raw material for critical evaluation. Most students will have read, or read about books 1, 2, 3 and 7.

The model will be organized into five sections. Each section will be divided into subsections, and each subsection will be divided into a presentation of material, a model (as defined in D.21) and student-involving exercises. Each section will be followed by a bibliography of resource material for the teacher relating to the aspect of C.4 covered in the section.

Introduction: Arguments and Their Evaluation

The purpose of this model is to provide the teacher with a basic guideline for successfully teaching correct critical thinking. This involves teaching correct reasoning abilities and the ability to detect incorrect reasoning. The way we, in fact, reason is often silly, fallacious, unsound or incomprehensible. Such reasoning may be said to be incorrect reasoning. Our concern will be to show how our reasoning, as embodied in our use of language, can be exposed and studied. For this purpose, we shall limit our concern with language to combinations and relationships among statements and their constituent parts.

The study of language, of course, is not exhausted by the study of reasoning. Language has many functions; for example to ask questions, to tell jokes, to issue commands, to agitate or to arouse emotions, as well as to make statements.[144] More specifically, our interest is limited to the basic reasoning unit, the argument.

[144] I shall ignore in this elementary treatment, the controversy surrounding moral statements. However, I shall assume that moral statements do express propositions, and hence, are truth valued, although arguments are in order to support this position. Providing such arguments, however, are beyond the scope of this curriculum.

"Argument" commonly describes the actions among persons with opposing views about the same subject. For example, among parents and children over the use of the family car, or among siblings over the use of the television set. Sometimes these actions involve crying and screaming, other times they involve physical blows. One consequence of this view is that it takes at least two people to have an argument. However, we shall not use "argument" as it is commonly described.

We shall mean by "argument" a bit of reasoning consisting of statements called premises, and a statement called a conclusion. In such a bit of reasoning, the conclusion is said to "follow from" the premises. Presenting an argument then, is to state premises from which a particular conclusion is said "to follow." One consequence of this view is that it does not take at least two people to have an argument. It simply takes a statement of premises and a statement of conclusion said "to follow" from them.

Consider the following argument presented by Wilbur Glenn Voliva designed to support his view that the Earth is motionless and flat, with the North Pole in the center and the South Pole distributed around the circumference.[145]

First consider his argument designed to show that the Earth is motionless.

> "Can anyone who has considered this matter seriously honestly say that he believes the earth is traveling at such an impossible speed? If it is going so fast, which way is it going? It should be easier to travel with it than against it. The wind always should blow in the opposite direction to the way the Earth is traveling. But where is the man who believes that it does? Where is the man who believes that he can jump into the air, remaining off the Earth one second, and come down to the Earth 193.7 miles from where he jumped up?"[146]

Like many arguments we will be considering, this argument is not presented as clearly as it might be. To present his argument as clearly as possible, we may consider putting the argument into the following form, and calling it A.1:

A.1

1. If the Earth is traveling at 600,000 mph as astronomers claim, then the wind always blows in the opposite direction from which the astronomers claim the Earth is traveling.
2. If the Earth is traveling at 600,000 mph as astronomers claim, then if one jumps off the Earth's surface for one second, then one will come down 193.7 miles from where one jumps off.

[145] Gardner, Martin, Fads and Fallacies in the Name of Science: The Curious Theories of Modern Pseudo-Scientists and the Strange Amusing and Alarming Cults that Surround Them, pp. 16-19.

[146] Gardner, Martin, Fads and Fallacies in the Name of Science: The Curious Theories of Modern Pseudo-Scientists and the Strange Amusing and Alarming Cults that Surround Them, p. 17.

3. We know that it is not the case that the wind always blows in the opposite direction from which the astronomers claim the Earth is traveling.
4. We know that it is not the case that if one jumps off the Earth's surface for one second, then one will come down 193.7 miles from where one jumps off.
5. If it is not the case that the wind always blows in the opposite direction from which the astronomers claim the Earth is traveling, then it is not the case that the Earth is traveling at 600,000 mph as astronomers claim.
6. If it is not the case that if one jumps off the Earth's surface for one second, then one will come down 193.7 miles from where one jumps off, then it is not the case that the Earth is traveling at 600,000 mph as astronomers claim.
7. Therefore, it is not the case that the Earth is traveling at 600,000 mph as astronomers claim.

Secondly, consider his argument desinged to show that the Earth is flat. He presented a double-spread photograph showing 12 miles of the shoreline of Lake Winnebago, Wisconsin.

> "The camera used was a eight by ten Eastman view camera. The lens was exactly 3 feet above the water . . . ANYONE CAN GO TO OSHKOSH AND SEE THIS SIGHT FOR THEMSELVES ANY CLEAR DAY. With a good pair of binoculars one can see small objects on the opposite shore, proving beyond any doubt that the surface of the lake is a plane, or a horizontal line . . the scientific value of this picture is enormous.[147]

[147] Gardner, Martin, _Fads and Fallacies in the Name of Science: The Curious Theories of Modern Pseudo-Scientists and the Strange Amusing and Alarming Cults that Surround Them_, p. 18.

Again, this argument is not presented as clearly as it might be. To present this argument as clearly as possible, we may consider putting the argument into the following form and calling it A.2.

A.2

1. An eight by ten Eastman view camera takes accurate, undistorted pictures.
2. A picture taken with such a camera at distance d, three feet above the water showing 12 miles of shoreline on a clear, calm day on Lake Winnebago shows the small objects that are on the 12 miles of shoreline.
3. The picture shows that the surface of the lake is a plane or horizontal line.
4. This procedure may be repeated at any suitable location on the Earth with the same results.

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5. Therefore, the Earth is not a sphere, but is flat.

Both arguments A1 and A2 have statements numbered as premises and a statement as a conclusion that is said to "follow from" the premises. Yet A.1 and A.2 appeal to two different notions of "following from" the premises. A.1 is called a deductive argument. In A.1, the conclusion 7 is said to follow deductively from the premises. A.2 is called an inductive argument. In A.2, the conclusion 5 is said to follow inductively from the premises.

In order to be able to construct and to evaluate arguments like A.1 and A.2, we must first consider a detailed discussion of both deductive arguments and inductive arguments. The question to raise regarding A.1 and A.2 is "Do the premises entitle us to claim that the conclusion is true?" To ask this question about an argument is to begin to evaluate the argument.

First, however, we must become familiar with deductive and inductive arguments.

Models

(The models throughout are designed to provide suggestions to the teacher for relating the material presented to the reading. For the first section, Gardner and VonDäniken provide material easily transformed into deductive arguments by the teacher.)

1. Go through Gardner, Chapter 2, and point out the sections which contain arguments to support a particular conclusion. Consider the rest of Gardner's book and present arguments of both types.

2. Clarify these arguments by putting them into the form of premises and conclusions. (No need to worry about inductive versus deductive at this point.)

3. Distinguish an argument from an explanation. Show how arguments are used to support explanations. Show that the other books present explanations which are supported by arguments.

Exercises

1. Have the students go through Gardner, Chapter 3, and find an argument to support Donnelly's claim about the giant comet (p. 35-37). Number the premises and indicate the conclusion. Have them find and record other arguments in Gardner.

2. Under what condition is the conclusion of A.1 supported by the premises? Is the conclusion true? Are the premises true? Construct your own argument to show that the conclusion is not true.

3. Under what condition is the conclusion of A.2 supported by the premises? Is the conclusion true? Are the premises true? Construct your own argument to show that the conclusion is not true.

Section One: Deductive Arguments and Their Evaluation

Subsection 1 - The Logical Form of Statements

A.1 is a deductive argument composed of statements called premises, 1, 2, 3, 4, 5 and 6, and a statement called a conclusion, 7. Statements have certain properties that are important for their use in arguments. For our purposes here, every statement is either true or false. Although we often say in everyday language that some statement is "nearly true," this is not strictly speaking correct. We do not distinguish degrees of truth or falsehood. A statement's truth or falsehood is called its truth value. The ancient Greek philosopher Aristotle was the first to recognize the systematic importance of treating every statement as either true or false. Aristotle's statement of this principle is often called the Law of Excluded Middle because it excludes the possibility of any truth value "in the middle" between true and false.

Another property of statements that is important for statement use in arguments is that no statement is both true and false. This is called the law of non-contradiction. To state, without qualification, that something both is and is not the case is to say something logically self-contradictory, or logically impossible. Logical impossibility is just one kind of impossibility. To clarify the notion of logical impossibility it is helpful to compare it with some other kinds of impossibility.

We might say that some state of affairs is technologically impossible if with our current technology, we are unable to bring it about. For example, it is technologically impossible to perform a human brain transplant. Such surgery does not violate any known laws of science. However, given our current technology, such surgery cannot be performed. Therefore, we say that a human brain transplant is currently technologically impossible.

We might say that some state of affairs is physically impossible if it violates any known natural laws (in the broadest sense). For example, it is physically impossible to travel faster than the speed of light. However, it is at least conceivable that the universe could have been different such that we could travel faster than the speed of light.

There are many other kinds of impossibility, but we need not consider them all to see that anything that is technologically or physically impossible is not necessarily logically impossible. Some statement is logically impossible iff it violates the laws of logic, in particular the law of non-contradiction. For example, it is logically impossible that the Earth is traveling at 600,000 mph and it is not the case that the Earth is traveling at 600,000 mph. The law of non-contradiction states that all such statement <u>must be false</u> because of their logical form.

To clarify the notion of the logical form of a statement, let us use the letter 'P' to stand for the statement 'the Earth is traveling at 600,000 mph' and let the symbol '∿' stand for the phrase "it is not the case that', or 'not', and let '·' stand for the English word 'and'. Thus, this sentence can be represented as 'P · ∿ P'. This representation of the sentence captures its logical form. No matter what statement we substitute for P, the resulting statement with this logical form is logically impossible and therefore must be false.

Therefore, we may distinguish statements which happen to be false because of the way the world is and statements which must be false because of their logical form. Consider a statement from A.1. Statement 7 happens to be false because of the way the world is: the Earth <u>is</u> traveling around the Sun at approximately 600,000 mph. To determine that 7 is false, we must refer to the way the world is. However, this is not necessary with statements having the logical form 'P and not P'. To determine that the statement 'the Earth is traveling at 600,000 mph and it is not the case the the Earth is traveling at 600,000 mph' is false, we need only examine its logical form. We need not refer to the way the world is. The law of non-contradiction guarantees that any statement with that logical form must be false.

Models

1. Go through Gardner, Chapter 4, to point out Charles Fort's views about the Earth, its motion, etc., and formulate a list of statements. Show that they are false because of the way the world is, not because of their logical form. Do the same thing for the other arguments you have presented to them from Gardner.

2. Define consistency and relate it to explanations. Show that Charles Fort's explanations are consistent. Relate this to A.1, and show that argument A.1 is consistent. Provide an explanation for lightning that is consistent but obviously false. Ask the students to produce an argument to show that it is false.

3. Present an explanation that is inconsistent (with a non-blatant contradiction). Consider VonDäniken's acceptance of Vellikofsky's explanation of the creation of Venus 10,000 years ago, and VonDäniken's assertion that ancient cave drawings of the heavens over 100,000 years old accurately show the position of Venus. Go through any of the other books you choose and do the same thing.

Exercises

Read Gardner, Chapter 9.

1. Determine why the following statements are false:

   a) Dowsing with a hazel twig will find oil every time.

   b) The Earth is flat as a pancake, with the north pole in the middle, and the south pole spread around the diameter.

   c) The Earth is flat as a pancake with a diameter of x miles and a circumference of y miles, and the volume of the Earth may be calculated by using the formula to find the volume of any sphere.

   d) The speed of a flying saucer is 930,000 miles per second.

   e) If Voliva is right, then the Earth is flat, and Voliva is right, but the Earth is not flat.

2. Write up an argument to refute the obviously false explanation for lightning presented by the teacher.

Subsection 2 - Logical Form and Logical Connectives

All statements with the logical form 'P . ∿ P' must be false. But statements can have other logical forms as well. We may capture the logical form of statements by replacing a statement at each of its accurrances with a letter called a propositional constant, like P above, and connecting the statements to other statements with what are called logical connectives like 'and' and 'not' above. It should be obvious that the other statements replaced by other propositional constants like 'Q . ∿ Q' have the same logical form as 'P · ∿ P'. To express this insight, let us use geometrical shapes such as O and Δ as variables which take these propositional constants like P and Q as values. Thus, the logical form of all these statements can be represented by propositional variables as 'O · ∿ O'.

Since we know, given the law of excluded middle, that every statement is either true or false, and given the law of non-contradiction, that every statement is not both true and false, we may use propositional variables like O and Δ and this knowledge about statements to understand what are called the logical connectives. In English, the logical connectives are 'not', and 'and', 'or', 'if-then', 'if and only if'.

Not - Negation. ∿ O is the negation of O. Clearly if O is true and if we deny O, then that negation is false. If O is false, and if we deny O, then that negation is true. Letting 't' stand for true and 'f' for false, these insights can be represented in what we call a truth table.

O	∿ O
t	f
f	t

This is called a truth table for 'not'. The important point here that we will apply to complex statements like 1 in A.1. can be seen by seeing that the truth or falsity of $\sim O$ varies with the truth or falsity of O. We say that the truth value of $\sim O$ is a function of the truth value of O. In general, we say that the truth value of a statement with a complex logical form, where logical form is limited to relations among statements, is a function of the truth values of the simple statements composing the complex statements. This is called truth functionality of statements and forms the basis for what we call the propositional calculus, or statement logic.

And - Conjunction. Consider such a complex statement which is a conjunction of two simple statements. This statement will have the logical form $O \cdot \Delta$. There are four possible combinations of truth values of the component statements. We can determine the number of logically possible combinations of truth values for a complex statement by the formula 2n, where n equals the number of simple statements used to form the complex statement. Thus, there are four possible combinations of truth values for a statement having the logical form $O \cdot \Delta$, and there are eight possible combinations of truth values for a statement of the logical form $O \cdot \Delta \cdot \nabla$.

Consider a statement of the logical form O · Δ to determine what the truth values of this complex statement are in each of the four possible truth values of the component statements satisfying 'O' and 'Δ'.

O	Δ	O · Δ
t	t	t
f	t	f
t	f	f
f	f	f

We see that a conjunction of statements is true iff all the component statements are true.

Or - Disjunction. Consider a complex statement which is a disjunction of two simple statements. Unfortunately the English word 'or' is ambiguous. Consider the following:

(i) It is raining or it is blowing.

(ii) Either we shall go to the Bahamas or we shall go to Arizona.

Disjunct (i) is interpreted as stating that it is raining, or blowing, or both, (ii) is interpreted as stating that we shall not go to the Bahamas and Arizona; we shall go only to one of the two. These two senses of 'or' are called, for (i), the inclusive sense, and for (ii), the exclusive sense. For the purposes of the propositional calculus, we only recognize the inclusive sense (i). We can always make the exclusive sense explicit in the propositional calculus by rewriting the statement such that both component statements cannot be true, using conjunction.

(iii) It is not the case that we shall go to the Bahamas and to Arizona.

Consider a statement of the logical form (i). If we let the propositional constants 'P' stand for 'it is raining' and 'Q' stand for 'it is blowing', and let the wedge 'V' stand for the inclusive sense of 'or'; (i) has the logical form 'P V Q'. Now 'P V Q' is true if any one of the following are the case:

P is true and Q is false.

P is false and Q is true.

P is true and Q is true.

'P V Q' is false if both P an Q are false. Consider the following truth table for disjuntions using propositional variables 'O' and '∆':

O	Δ	O V Δ
t	t	t
f	t	t
t	f	t
f	f	f

We see that a disjunction of statements is false iff both the component statements are false.

<u>If - Then - Conditional</u>. We may now consider a complex statement used as premises 1, 2, 5 and 6 in A.1 Instead of being one word like 'and', or 'or' standing between two component statements, a conditional statement is formed by writing 'if' before the first component statement, and 'then' between the first and the second component statement. This can be seen by considering premise 1 of A.1. The logical form of A.1 1, can be seen by substituting the propositional constant 'P' for 'the Earth is traveling at 600,000 mph as astronomers claim' and by substituting the propositional constant 'Q' for 'the wind always blows in the opposite direction from which the astronomers claim the Earth is traveling' and letting the horseshoe '$\supset$' stand for the conditional connective 'if . . . then'. Thus, A.1 1 becomes '$P \supset Q$'.

Three technical terms must now be introduced. The statement following 'if' and preceding 'then', P above, is called the antecendent of the conditional. The statement following 'then', Q above, is called the consequent of the conditional. Note that the antecedent does not include 'if' nor does the consequent include 'then'. These words are the logical connective.

Letting 'O' and 'Δ' be propositional variables to capture the logical form of statements like A.1 1, we must now consider the truth values of the complex statement $O \supset \Delta$ in relation to each of the four possible truth values of the component statements satisfying O and Δ. To do so, we must recall that such complex statements are truth functional and that the law of excluded middle states that every statement is either true or false, with no truth value in between.

The problem with applying these principles to the English use of 'if . . . then . . .' arises since the English connective signifies many different types of connections. For example, sometimes it is used to mean class inclusion;

(i) If Spot is a dog, then Spot is an animal.

or to mean causal connection;

(ii) If Steve is late, then he will miss the bus.

Or sometimes it is used with no apparent connection at all;

(iii) If Voliva was a scientist, then Nixon was a saint.

The problem, then, is that there is no easy way to capture all these different senses of the conditional in our symbolic system. However, we can solve this problem by noticing that all these senses (i), (ii) and (iii) have in common that each is false if the antecedent is true and the consequent is false. Note that this is the same as saying that $O \supset \Delta$ is false when $O \cdot \sim \Delta$ is true, because when Δ is false, $\sim \Delta$ is true. Now if $O \supset \Delta$ is false when $O \cdot \sim \Delta$ is true, then $O \quad \Delta$ is true when $O \cdot \sim \Delta$ is false. This is so because of the truth table for negation and because of the law of excluded middle. This can be seen as follows:

O	Δ	$O \cdot \sim \Delta$	$\sim (O \cdot \sim \Delta)$	$O \supset \Delta$
t	t	f	t	t
f	t	f	t	t
t	f	t	f	f
f	f	f	t	t

We see that a conditional statement is false iff the antecedent is true and the consequent is false. This is intuitively clear. However, the other assignments of truth values to the conditional are not intuitively clear.

We must, therefore, provide some motivation for making the assignments in these unclear cases.

No matter how we interpret the conditional, there are certain logically complex statements that we want to have a certain truth value, given the assignment of truth values to its component statements. By considering such a statement and what assignments it requires us to make, we can determine the assignments of truth value to conditionals when the antecedent and the consequent are both true, when the antecedent is false and the consequent is true, and when the antecedent and consequent are both false.

Consider the logically complex statement "if O · Δ then O." First, consider the problem of assigning a truth value to a conditional in which both antecedent and consequent are true. Intuitively, given that O is true and Δ is true, we want to be able to say that "if O · Δ then O" is true (if t · t, then t). Since given this true antecedent, a true consequent follows. To capture this intuition, we must assign a value of true to 'O ⊃ Δ' when both antecedent and consequent are true. Assigning false to such a conditional would violate this intuition. Therefore, we rule it out and call such conditionals true.

Secondly, consider the problem of assigning a truth value to a conditional in which the antecedent is false and the consequent is true. Intuitively, given O is false and W is true, we want to be able to say that "if O · Δ then O" is true (if f · t, then t), since given this false conjunction as antecedent, this true consequent follows since O is true. To capture this intuition, we must assign a value of true to 'O ⊃ Δ' when the antecedent is false and the consequent is true.

Thirdly, consider the problem of assigning a truth value to a conditional in which the antecedent and the consequent are both false. Intuitively, given O is false and Δ is false, we want to be able to say that "if O · Δ then O" is true (if f · f, then f) since given this false antecedent, a false consequent truly follows, since O is false. To capture this intuition, we must assign a value of true to 'O ⊃ Δ' when both the antecedent and consequent are false. We distinguish this conditional from the many other conditionals used in English and we call it the material conditional.

<u>If and Only If - Biconditional</u>. A statement using the biconditional as a logical connective is the conjunction of a conditional and what we call its converse. If we switch

the antecedent and the consequent of a given conditional statement, we get the converse of that conditional statement. Thus the converse of the statement A.1 1, symbolized in terms of propositional constants as 'P ⊃ Q', is 'Q ⊃ P'. Note that we cannot automatically conclude from the truth of a statement the truth of its converse.

A.1 1 and its converse, then, can be represented in terms of propositional constants as

(i) P ⊃ Q, and

(ii) Q ⊃ P

Another way to translate 'P ⊃ Q' into English is 'P only if Q' (i.e., the Earth is traveling at 600,000 mph as astronomers claim only if the wind always blows in the opposite direction from which astronomers claim the earth is traveling). This is not the same as 'P if Q'. Another way of saying 'P if Q' is to say 'Q then P', or equivalently, 'Q only if P'. This is obviously not the same as 'P only if Q'. This conjunction of (i) and (ii) is (iii) (P ⊃ Q) (Q ⊃ P). Another way to translate (P ⊃ Q) · (Q ⊃ P) into English is 'P if and only if Q'. Let triple bar '≡' stand for the logical connective 'if and only if'. We can form the truth table for this logical connective by considering the truth tables for conjunctions and conditionals. Again, using 'O' and 'Δ' as propositional variables.

O	Δ	$O \supset \Delta$	$\Delta \supset O$	$O \equiv \Delta$
t	t	t	t	t
f	t	t	f	f
t	f	f	t	f
f	f	t	t	t

Models

1. Assemble the arguments you have presented from Gardner that can be put into deductive form. Point out the logical connectives and use truth tables to provide the possible assignments of truth values. Point out the logical connectives in all the arguments you have considered.

2. Write up truth tables showing the possible truth value assignment to various negations, conjunctions, disjunctions, etc. Have the student pick out the assignments that are, in fact, the case and show why.

3. Mix in with the above statements statements both true in all interpretations and false in all interpretations and ask them to pick out the assignments that are, in fact, the case and show why.

Exercises

1. Assemble a body of complex statements from Gardner or any of the other books the students are reading. Ask them to point out the logical connectives, and provide truth tables for the complex statements.

2. Ask the students to present an informal argument refuting one or more of the explanations Gardner considers. Ask them to use the symbols for logical connectives we have provided.

Subsection 3 - Capturing the Logical Form of Complex Statements: PC

Given the notion of a statement's logical form, propositional constants which are chosen to stand for specific statements univocally, and the logical connectives, we may capture the logical form of simple statements and of complex statements composed of simple statements joined by one or more of the logical connectives. This we shall call translating statements into the propositional calculus. However, before discussing translating English statements into PC, we must formally introduce another notational device informally used above. Suppose we are trying to determine the truth value of the statement 'P · Q V R'. We seem to be stuck because our truth tables for conjunction and disjunction only tell us how to deal with two symbols and one connective. However, we may use parenthesis in logic the way we use them in mathematics to solve this problem. For example, in ENT, the value of 27 + 3 will be 27 or 3 depending on how we remove the ambiguity (i.e., (27 ÷ 3) x 3, or 27 ÷ (3 x 3)). Similarly in PC, 'P · Q V R' is ambiguous between '(P · Q) V R' and 'P · (Q V R)'.

However, once such complex statements are grouped by parenthesis, we may determine its truth value given that we know the truth values of its component statements. For example, suppose that P is false, Q is true and R is true. Given '(P · Q) V R', we can substitute (P · Q) for the O and R for the Δ in our truth table for disjunction. We then substitute P for O and Q for Δ in the truth table for conjunction, and see that 'P · Q' is f, since P is f. Since R is t, '(P · Q) V R' will be t given the truth table for disjunction. Writing truth values in place of propositional constants to assist the computation, we see given these truth values for P, Q and R:

$$(f \cdot t) \vee t = f \vee t = t.$$

Applying the same principles to 'P · (Q V R)' we see that

$$f \cdot (t \vee f) = f \cdot t = f$$

We can easily see that '(P · Q) V R' is not logically equivalent to 'P · (Q V R)' since given the same truth values for the same propositional constants, the truth values of the complex statements are different.

It is important here to see that we may substitute complex statements for the O and the Δ in truth tables for any of the logical connectives. Therefore, we may use this method to calculate the truth values of statements as complex as we want, given that we know the truth values of the component statements.

To translate such complex statements into PC, we need only (1) recognize logical connectives, and (2) assign propositional constants univocally. Let's consider the premises and conclusions of A.1, and translate the statements composing this argument into PC.

Consider premise 1. We have translated this statement into PC. Premise 1 becomes 'P $\supset$ Q'. Once deciding that 'P' stands for 'the Earth is traveling at 600,000 mph as astronomers claim; we must replace this statement with P wherever it occurs in the argument, or in a complex statement. This guarantees that we capture the logical form of the particular statement of this sort and the logical form of the argument, as we shall consider it in a minute. This is what (2) means above.

Consider premise 2. Premise 2 is a logically more complex statement than premise 1, and requires the correct use of parenthesis. The logical form of the large complex statement is a conditional. However, we see that the consequent of the conditional is simply another conditional. Following the univocal assignment of propositional constants, we see that the antecedent of this premise is 'P'. The consequent is yet another conditional. Let 'R' stand for 'one jumps off the Earth's surface for one second' and let 'S' stand for 'one will come down 193.7 miles from where one jumps off'. We may use parentheses to capture this consequent which is also a conditional as follows:

'$P \supset (R \supset S)$'

This is the translation of premise 2 into PC.

Consider premise 3. This is very simple. 'Q' already stands for 'the wind always blows in the opposite direction from which the astronomers claim the earth is traveling'. Premise 3 is the negation of 'Q', so premise 3 is simply translated as '$\sim Q$'. Likewise, premise 4 is simply the negation of the consequent of premise 2, so premise 4 is translated as '$\sim (R \supset S)$'.

Consider premise 5. Following the recognition of logical connectives and the univocal use of propositional constants, premise 5 is simply a conditional with the negation of Q as the antecedent and the negation P as the consequent. So premise 5 is translated as '$\sim Q \supset \sim P$'.

Consider premise 6. Premise 6 is simply a conditional with the negation of (R S) as the antecedent and the negation of P as the consequent. So premise 6 is translated as '∿ (R S) ∿ P'. The conclusion, 7, is simply translated as the negation of P, '∿ P'.

We may, therefore, present the translation of the statements forming A.1 as follows:

<u>A.1</u>

1. P Q
2. P (R S)
3. ∿ Q
4. ∿ (R S)
5. ∿ Q ∿ P
6. ∿ (R S) ∿ P

---

7. ∿ P

Given Voliva's original statements, we see the difficulty in clearly translating chunks of English prose (that are claimed to be arguments) into our symbolic notation. However, in summary, here are some suggestions.

1. Locate the conclusion. It is often preceded by the word 'therefore' or the word 'thus'. However, it need not be. Practice is a sure way to locate conclusions.

2. Locate the premises. Not all sentences that appear in a bit of prose are statements. Furthermore, not all statements that appear in a bit of prose need be either premises or a conclusion. Therefore, you must learn to recognize and to disregard invectives, commands, rhetorical questions and irrelevant statements.

3. Locate the logical connectives. They are the key to capturing the logical form of the relevant statements and and the logical form of the arguments.

Models

1. Here, the teacher must provide many examples of translation. Consider all the arguments you have dug out of Gardner. Translate them, explaining the grouping very carefully.

2. Consider complex statements making up arguments provided in the logic texts listed in the bibliography. Use them as exercises to be worked to show how translations work.

3. Use student exercises and attempt to translate them into PC.

Exercises

1. Ask the students to translate their own argument (from Subsection 2) into PC. If they cannot or if they do so incorrectly, they may discover there is more to logical form than just PC. This will anticipate later developments in Section One.

2. Give the students a chance to translate some PC arguments that you point out in any of the books, or that you find in any of the logic texts listed in the bibliography.

Subsection 4 - Capturing the Logical Form of Arguments

Having captured the logical form of the statements used in premises and the statement of the conclusion in an argument like A.1, we may now consider what we may call the logical form of the argument itself. For (deductive) arguments like A.1, to discover the logical form of the argument is to discover whether or not the argument is valid. Validity is a logical relation among statements. An argument with a logical form that is valid is an argument whose conclusion is true _if_ its premise are true, and the premises are said to logically imply the conclusion. Informally speaking, we can say that the conclusion is, in some sense, already "contained in" the premises.

For example, consider the following simple argument designed to show a valid logical form:

4.1

1. If Columbus is right, then the Earth is round.
2. Columbus is right.

Therefore (here written ':.')

:. 3. The Earth is round.

The translation of the premises and conclusion of this argument can be seen as follows using 'T' and 'U' as propositional constants.

4.2

1. $T \supset U$
2. T

:. 3. U

If we know that premises 1 and 2 are true, and that the argument has a valid logical form, then we may determine that the conclusion 3 is true, without circumnavigating the globe.

However, in fact, an argument with a valid logical form may have a false conclusion, but only if at least one of the premises is false. Consider the following argument:

4.3

1. If Voliva is right, then the Earth is flat.
2. Voliva is right.

:. 3. The Earth is flat.

The translation of the premises and conclusion of this argument can be seen as follows using 'T'' and 'U'' as propositional constants:

4.4

1. $T' \supset U'$
2. T'

:. 3. U'

This shows us clearly that 4.3 has the same valid logical form as 4.1, since 4.2 and 4.4 have the identical form. However, unlike 4.1, 4.3 has a false conclusion: 'the Earth is flat' is false. Yet also unlike 4.1, 4.3 has a false premise: premise 2 in 4.3 is false. The only requirement that a valid argument with a false conclusion must satisfy is that at least one of the premises must be false.

An argument with a valid logical form and with one or more false premises may also have a true conclusion. Consider the following argument:

4.5

1. If Voliva is a turkey, then he is mortal.
2. Voliva is a turkey.

:. 3. Voliva is mortal.

4.5, like 4.1 and 4.3, has a valid logical form, and the conclusion is true. Premise 2, however, is false. Premise 1 is true: as a fact of biology, if anything is a turkey, then it is mortal.

It should be clear from these considerations then, that arguments with valid logical form may have conclusions that are true or false, but it is logically impossible for an argument to have a valid logical form and true premises, and a false conclusion.

To distinguish such arguments with valid logical forms and true premises from arguments with valid logical forms but one or more false premises, we introduce the notion of a sound argument. An argument is sound when it is valid and its premises are true. Therefore, 4.1 is a sound argument, but 4.3 and 4.5 are unsound.

It is also useful to point out that an invalid argument is simply an argument that does not have a valid logical form. Invalid arguments can have any combination of truth values in their premises and conclusions. Therefore, just because an argument is invalid, we cannot assume that the conclusion is false; it may be the conclusion of another sound argument, or it may be factually true anyway.

Many students confuse the notion of truth with the notion of validity. Recall that truth is a property of certain statements and validity is a logical relation between certain statements. Therefore, strictly speaking, it makes no sense to say that a statement is valid and an argument is true. Validity and truth are quite different sorts of things. In fact, in advanced logics, we can define validity without any recourse whatsoever to the notion of truth.

Models

1. Carefully explain validity, truth and soundness. Provide examples of each from the arguments you have already dug out of Gardner; show the ones you have reconstructed that are valid, yet unsound.

2. Explain carefully what the importance of validity is for arguments - to preserve truth. Anticipate more complex arguments where the logical form is not obvious and use some examples from science.

3. Discuss the importance of validity for organizing writing and presenting original arguments. Show how it can be used to organize long as well as short essays. Consider Charles Darwin's letter to Gray as an example of this use of valid logical form.

4. Emphasize the usefulness of valid arguments and their importance for presenting original arguments, critical arguments, as well as evaluating given arguments.

Exercises

1. Have the students point out unsound arguments offered in support of the explanations Gardner considers.

2. Have the students examine arguments with true con- conclusions that are valid and unsound, with true con- clusions that are invalid, and with true conclusions that are valid and sound. Ask them to explain the relation of these concepts in the particular arguments. (You may take these from the logic texts, or make them up yourself.)

Subsection 5 - Testing the Validity of Arguments

Given the above, we can modify the definition of validity to provide a test for validity. An argument is valid just in case it is logically impossible for the premises to be true and the conclusion false. That is, the argument can be determined to be valid just in case you get a contradiction by asserting the (conjunction of the premises) and the denial of the conclusion. This, then, gives us the means to test the validity of arguments; conjoin the premises with the denial of the conclusion. If a contradiction results, then the argument has a valid logical form.

Recall that a contradiction is false in virtue of its logical form alone. We can give a clear meaning to this by a truth table. Consider a contradiction 'P · ∿ P'. To provide a truth table, we need only consider two cases - case 1 where P is true and ∿ P is false, and case 2 where P is false, and ∿ P is true. The law of non-contradiction rules out the cases where P and ∿ P are both true or both false:

P	∿ P	P · ∿ P
t	f	f
f	t	f

As expected, 'P · ∿ P' is false under every possible assignment of truth values to the propositional constant P. The insight to see here is that any contradiction is false under every possible assignment of truth values.

Consider an argument we said was valid above, 4.2, and let's test it for validity by applying the test.

5.1

	1.	$T \supset U$
	2.	T
$\therefore$	3.	U

In order to test for validity, we take the conjunction of the premises and conjoin that with the denial of the conclusion and test to see whether or not it is a contradiction. Thus, to test 5.1, we shall test the statement '$((T \supset U) \cdot T) \cdot \sim U$'. We carry out this test by using a truth table. Since there are two predicate constants, there will be four possible combination of truth values of component statements.

T	U	$((T \supset U) \cdot T) \cdot \sim U$
t	t	$(t \cdot t) \cdot f = t \cdot f = f$
f	t	$(t \cdot f) \cdot f = f \cdot f = f$
t	f	$(f \cdot t) \cdot t = f \cdot t = f$
f	f	$(f \cdot f) \cdot t = f \cdot t = f$

Since this statement is false under every possible assignment of truth values to the component propositional constants, it is a contradiction. Therefore, 5.1 (and any argument of the same form) is <u>valid</u>.

We shall call this method for testing arguments for validity the method of truth tables. This method also allows us to test and point out invalid arguments as well. Consider the following invalid arguments:

5.2

1. If Voliva is right, the the Earth is flat.
2. The Earth is flat.

∴ 3. Voliva is right.

Again, substituting 'T'' for 'Voliva is right' and 'U'' for 'the Earth is flat,' 5.2 may be translated into PC as follows:

5.3

1. $T' \supset U'$
2. U'

∴ 3. T'

Again, to test for validity, we conjoin the conjunction of the premises with the denial of the conclusion and see if we get a contradiction. Thus, to test 5.3, we shall test the statement '$((T' \supset U') \cdot U') \cdot \sim T'$'. Again, we carry out this test by using a truth table.

T'	U'	$((T' \supset U') \cdot U') \cdot \sim T'$
t	t	$(t \cdot t) \cdot f = t \cdot f = f$
f	t	$(t \cdot t) \cdot t = t \cdot t = t$
t	f	$(f \cdot f) \cdot f = f \cdot f = f$
f	f	$(t \cdot f) \cdot t = f \cdot t = f$

In only one case (where T' is false and U' is true) is the statement under consideration true. But one case is sufficient to show that this statement is not a contradiction; a contradiction is never true. Therefore, this argument (and any other argument of the same logical form), is invalid.

We, therefore, have a powerful method for testing an argument for validity. Given a symbolic translation of any such argument in English, we can test that argument by the method of truth tables and prove that it is valid or prove that it is invalid. However, longer and more complex arguments, for example like A.1, make this process rather cumbersome. One way to shorten this process is to name certain recurring valid argument forms, allowing us to recognize a particular argument, or step in a complex argument, as an instance of one of these valid argument forms. However, the problem with this method is that we cannot be sure that every possible argument will be an instance of one or more of these forms. For this reason, we may simply state certain rules that apply the logical connectives to relations among statements. We may then simply cite these rules in what we shall call a proof of an argument's validity.

Models

1. Here it is important to work many truth table tests for the validity of arguments. Attempt to use previously constructed or reconstructed arguments from the reading. This will help anticipate the formulation and clarification of arguments later to be considered specifically.

2. Provide truth table tests for some of the arguments provided by the students. Point out the ones that are obviously non-deductive arguments and anticipate the discussion of induction by showing that deductive invalidity does not necessarily mean that the argument is no good, if it is inductive.

3. Point out the relation of validity and truth by numerous examples. Consider examples from the logic texts in the bibliography.

Exercises

1. Have the students work many truth table tests for the validity of arguments. Mix valid and invalid arguments you have provided from the reading. (VonDäniken is a good source for providing such arguments). Have them translate and test the argument for validity, and indicate whether it is sound.

2. Provide them with at least one long, more complex argument so they will see by experience that the method of truth tables has serious limitations.

Subsection 6 - Rules of Valid Inference

The intuition here is simple. Given the logical connectives and propositional variables, we need a rule that allows us validly to introduce each logical connective and a rule that allows us validly to eliminate each logical connective. These rules are based on the law of non-contradiction and the truth functionality of propositions.

Consider negation. The rule applying to negation has been called Reductio ad Absurdum, but we shall divide the rule into two distinct parts and show why the move is logically valid. First, consider negation introduction, written ∿ I. This states that we may assume the negation of any proposition in order to derive a contradiction. Having derived a contradiction, we may then conclude the negation of the introduced negation. We know that if ∿ O leads us validly to a contradiction, then ∿ ∿ O will avoid the contradiction. ∿ I requires what we shall call a sub-proof, or a proof within a proof. We will indicate this type of subproof by drawing an arrow to the first line of the subproof, and boxing the subproof such that the conclusion proven by the subproof is just below the box. The subproof for ∿ I requires that from an assumed negation, we validly produce a contradiction. Once proving this contradiction, ∿ I allows us validly to conclude the negation of our assumption. We shall see how this works more clearly in a moment. For now, it is sufficient to see that ∿ I allows the following valid inference from a subproof:

1. ∿ O assume
2. ∿ O leads validly to a contradiction

:. 3. ∿ ∿ O (∿ I)

Secondly, consider negation elimination, written $\sim$ E. $\sim$ E allows us to write '$\sim \sim$ O' as simply O since the negation of a negation of any proposition is logically equivalent to the proposition; they have the same truth value under the same interpretation of O.

O	$\sim$ O	$\sim \sim$ O
t	f	t
f	t	f

Therefore, O is logically equivalent to $\sim \sim$ O. Whenever two logically complex statements have exactly the same truth values for all possible assignments of truth values, those two statements are logically equivalent. However, this does not mean that the two statements are equivalent in all respects.

Consider conjunction. (Refer to the truth table for conjunction.) Conjunction introduction, written .I, allows the following valid inferences:

1. O
2. Δ

$\therefore$ 3. O $\cdot$ Δ (.I)

Again, we may use the truth table method to prove this inference valid.

O	Δ	((O · Δ) · ∿ (O · Δ))
t	t	t · f = f
f	t	f · t = f
t	f	f · t = f
f	f	f · t = f

Conjunction elimination, written .E, allows the following valid inference:

1. O · Δ

:. 2. O (.E)

Again, using the truth table method:

O	Δ	((O · Δ) · ∿ O)
t	t	t · f = f
f	t	f · t = f
t	f	f · t = f
f	f	f · t = f

Consider disjunction. (Refer to the truth table for disjunction.) Disjunction introduction, written VI, allows the following valid inference:

1. O

:. 2. O V Δ (VI)

Again using the truth table method:

O	Δ	(O · ∿ (O V Δ))
t	t	t · ∿ (t) = f
f	t	f · ∿ (t) = f
t	f	t · ∿ (t) = f
f	f	f · ∿ (f) = f

Disjunction elimination, written VE, allows the following valid inference:

1. O V Δ
2. ∿ O
3. Δ (VE)

Again, using the truth table method:

O	Δ	(((O V Δ) · ∿ O) · ∿)
t	t	(t · f) · f = f
f	t	(t · t) · f = f
t	f	(t · f) · t = f
f	f	(f · t) · t = f

Consider the material conditional. (Refer to the truth table for the material conditional.) Conditional introduction, written ⊃ I, like ∿ I, has its own name. This has been called conditional proof. As we shall see, ⊃ I like ∿ I, requires that we shall call a subproof. ⊃ I allows us to assume O and then if we can prove Δ using valid rules of inference and the other propositions available to us, then we can conclude $O \supset \Delta$. $\supset$I allows the following valid inference from a subproof:

1. O Assume
2. O and the other propositions available to us lead validly to Δ.

$\therefore$ 3. $O \supset \Delta$ ($\supset$I)

Conditional elimination, written $\supset$E, includes two rules of inference traditionally known as <u>modus ponens</u> and <u>modus tollens</u>. $\supset$E allows either of the following valid inferences:

1. $O \supset \Delta$
2. O

$\therefore$ 3. Δ ($\supset$E)

<u>OR</u>

1. $O \supset \Delta$
2. $\sim \Delta$

$\therefore$ 3. $\sim O$ ($\supset$E)

Again using the truth table method:

O	Δ	$(((O \supset \Delta) \cdot O) \cdot \sim \Delta)$	$(((O \sim \Delta) \cdot \sim \Delta) \cdot \sim \sim O)$
t	t	$(t \cdot t) \cdot f = f$	$(t \cdot f) \cdot t = f$
f	t	$(t \cdot f) \cdot f = f$	$(t \cdot f) \cdot f = f$
t	f	$(f \cdot t) \cdot t = f$	$(f \cdot t) \cdot t = f$
f	f	$(t \cdot f) \cdot t = f$	$(t \cdot t) \cdot f = f$

Consider the biconditional. (Refer to the truth table for the material biconditional.) Biconditional introduction, written $\equiv$ I, allows the following valid inference:

1. $O \supset \Delta$
2. $\Delta \supset O$

$\therefore$ 3. $O \equiv \Delta$ ($\equiv$ I)

Again using the truth table method:

O	Δ	$(((O \supset \Delta) \cdot (\Delta \supset O)) \cdot \sim (O \equiv \Delta))$
t	t	$(t \cdot t) \cdot \sim (t) = f$
f	t	$(t \cdot f) \cdot \sim (f) = f$
t	f	$(f \cdot t) \cdot \sim (f) = f$
f	f	$(t \cdot t) \cdot \sim (t) = f$

Biconditional elimination, written $\equiv$ E, allows the following valid inferences:

1. $O \equiv \Delta$
2. O

$\therefore$ 3. Δ ($\equiv$ E)

OR

$$\begin{array}{rl} & 1.\ \ O \equiv \Delta \\ & \underline{2.}\ \ \sim O \\ \therefore & 3.\ \ \sim \Delta\ (\equiv E) \end{array}$$

OR

$$\begin{array}{rl} & 1.\ \ O \equiv \Delta \\ & \underline{2.}\ \ \Delta \\ \therefore & 3.\ \ O\ (\equiv E) \end{array}$$

OR

$$\begin{array}{rl} & 1.\ \ O \equiv \Delta \\ & \underline{2.}\ \ \sim \Delta \\ \therefore & 3.\ \ \sim O \end{array}$$

Again using the truth table:

O	Δ	((O ≡ Δ) · O) · ∿ Δ	((O ≡ Δ) · ∿ O) · ∿ ∿ Δ
t	t	(t · t) · ∿ (t) = f	(t · f) · t = f
f	t	(f · f) · ∿ (t) = f	(f · t) · t = f
t	f	(f · t) · ∿ (f) = f	(f · f) · f = f
f	f	(t · f) · ∿ (f) = f	(t · t) · f = f

((O ≡ Δ) · Δ) · ∿ O	((O ≡ Δ) · ∿ Δ) · ∿ ∿ O
(t · t) · f = f	(t · f) · t = f
(f · t) · t = f	(f · f) · f = f
(f · f) · f = f	(f · t) · t = f
(t · f) · t = f	(t · t) · f = f

In addition to these rules, allowing us validly to introduce and validly eliminate these logical connectives, we may consider an additional valid rule of inference, called reiteration, written R. R allows the following valid inference:

$$\begin{array}{ll} & \underline{1.}\quad O \\ \therefore & 2.\quad O\ (R) \end{array}$$

Again using the truth table method:

O	(O · ∿ O)
t	f
f	f

Certain premises of arguments, which do not logically follow from other premises by these rules, we shall call assumptions. We shall use 'assumption' as a term referring to the logical status of a premise, just as the rules of valid inference refer to the logical status of the moves from one premise to another in an argument. Therefore, we need a rule of assumptions, written A, to guarantee that the conclusion is validly reached from those assumptions, and no others, using the above valid rules of inference. We may keep track of these assumptions by a simple proof procedure. Consider A.1, as translated into PC. Premise 1, 2, 3, and 4 are all assumptions. They stand on their own; they are logically independent. That is, they are not derived from other premises by the above rules of valid inference.

However, to test the validity of A.1, we must show that the conclusion, 7, is validly derived from just these four assumptions. We may not introduce other assumptions, unless they are part of what we have called a subproof for $\sim$ I, or for $\supset$ I. (Notice that these assumptions drop out of the proof when the subproof is concluded.) Consider A.1 as translated into PC:

1. $P \supset Q$ A
2. $P \supset (R \supset S)$ A
3. $\sim Q$ A
4. $\sim (R \supset S)$ A
5. Q and $P \supset Q$ allows us, by $\supset$ E, to derive $\sim P$. So we may, with Voliva, state:
   $\sim Q \supset \sim P$. This follows from 1, 3 and $\supset$ E.
6. Similarly, $\sim (R \supset S)$ and $P \supset (R \supset S)$ allows us again by $\supset$ E, to derive $\sim P$. So we may, with Voliva, state:
   $\sim (R \supset S) \supset \sim P$. This follows from 2, 4 and $\supset$ E.
7. $\sim P$, the conclusion, follows from 3, 5 and 4, 6 and $\supset$ E. Note that 3, 5, 4 and 6 are derived from 1, 2, 3 and 4. Therefore, 7 is derived from 1, 2, 3 and 4, and this argument satisfies the rule of assumptions.

A.1 can really be seen as two deductively valid arguments joined together.

<u>A.1</u> (i)

$$\begin{array}{lll} & 1. & P \supset Q \\ & \underline{2.} & \sim Q \\ \therefore & 3. & \sim P \end{array}$$

<u>AND</u>

<u>A.1</u> (ii)

$$\begin{array}{lll} & 1. & P \supset (R \supset S) \\ & \underline{2.} & \sim (R \supset S) \\ \therefore & 3. & \sim P \end{array}$$

Both are valid, and instances of $\supset$ E.

<u>Subsection 7 - Logical Equivalence</u>

Given the above rules of valid inference, we are now in a position both to evaluate given arguments like A.1, and also, given premises as assumptions and a conclusion, to attempt validly to deduce a conclusion from the assumptions. However, there are several other important logical tools to consider before constructing such proofs in earnest.

The first is a notion we already mentioned, logical equivalence. Given this notion, we may introduce what are called Demorgan's laws and the concept of a tautology. We stated that when two logically complex statements have exactly the same truth values for all possible assignments of truth values to their component statements, those two complex statements are logically equivalent. To test for logical equivalence of two such statements, we simply use the truth table method.

Two sets of logical equivalences have such usefulness that they are called Demorgan's laws, after the 19th century logician Augustus Demorgan. (However, they are also stated by William of Ockham in the 14th century.) These laws state that:

(i) $\sim (O \cdot \Delta)$ is logically equivalent to $\sim O \vee \sim \Delta$, and that

(ii) $\sim (O \vee \Delta)$ is logically equivalent to $\sim O \cdot \sim \Delta$

Consider (i). Again, these can be proven logically equivalent by the truth table method:

O	Δ	$\sim (O \cdot \Delta)$	$\sim O \vee \Delta$
t	t	$\sim$ (t) = f	f V f = f
f	t	$\sim$ (f) = t	f V f = t
t	f	$\sim$ (f) = t	f V t = t
f	f	$\sim$ (f) = t	f V t = t

Consider (ii). Again, these can be proven logically equivalent by the truth table method:

O	Δ	∿ (O V Δ)	∿ O · ∿ Δ
t	t	∿ (t) = f	f · f = f
f	t	∿ (t) = f	t · f = f
t	f	∿ (t) = f	f · t = f
f	f	∿ (f) = t	t · t = t

Demorgan's laws are useful because they allow us, in an argument, to avoid the negation of complex conjunctions and complex disjunctions. Therefore, we need never apply negation to a complex disjunction, or a complex conjunction. Therefore, we may replace any statement in an argument with a logically equivalent statement and preserve validity. Therefore, we may justify such a move simply by citing Demorgan's laws, written DM.

There are many other logical equivalences. For example,

(iii) ∿ (O ⊃ Δ) is logically equivalent to O · ∿ Δ.
(iv) ∿ (O ≡ Δ) is logically equivalent to ∿ O ≡ Δ and to O ≡ ∿ Δ.
(v) O ⊃ Δ is logically equivalent to ∿ O ≡ Δ.
(vi) O ≡ Δ is logically equivalent to (O · Δ) V (∿ O . ∿ Δ).

Again, in an argument, these may be justified simply by writing DM even though strictly speaking they are not Demorgan's laws.

It should be obvious that all contradictions are logically equivalent. Recall that contradictions are necessarily false because of their logical form. Just as there are necessarily false statements, there are necessarily true statements. As we might expect, these statements are necessarily true because of their logical form. Such necessarily true statements are called tautologies. Also, then, it should be obvious that all tautologies are logically equivalent.

Consider statements of the form $O \vee \sim O$:

O	$\sim O$	$O \vee \sim O$
t	f	t
f	t	t

Since statements of this form are true in all possible interpretations of their components, such statements are necessarily true. A tautology need not have the form $O \vee \sim O$. Just as with contradictions, there may be complex statements not of this form that are tautologies.

Models

1. Work logical equivalences using truth tables. Explain carefully that 'logical equivalence' does not mean 'has the same meaning,' i.e.,

   a) Mary got pregnant, and she was married.

1. b) Mary was married, and she got pregnant.

   Items a) and b) are logically equivalent because they have the same truth table, but a) and b) do not have the same meaning.

2. Consider the logic bibliography and prove some logical equivalences, explaining the assignments of truth values so that students can become familiar with the truth tables for the various logical connectives.

3. Explain carefully the use of logical equivalents in arguments; anticipate their use in proof strategies.

Exercises

1. Have the students show why, for the purpose of testing for validity, the order of the premises does not matter.

2. Have them prove, using the truth table method, that (ii), (iv), (v) and (iv) do express logical equivalents.

3. Have them prove that '$P \supset Q$' is logically equivalent to '$\sim Q \supset \sim P$'.

4. Consider any practice exercises in the logic texts useful here.

5. Have them take sets of statements and using Demorgan's, have them translate them into their logical equivalents. Then have them test the results.

Subsection 8 - Proofs of Deductive Validity: PC

Given these rules of valid inference and the ability to translate such arguments into PC symbols, we must now establish what we shall call a proof procedure. Suppose that we are given the assumptions and asked validly to derive a specific conclusion from them. Our proof procedure is as follows:

First, we write and number the assumptions, and on the right side, indicate A as a justification. We shall also use A for assumptions in subproofs. We shall justify each line of the proof numbered consecutively on the left to the right of the line and indicate which previous lines and which rule justify that line. Then, when we reach the conclusion, we can check to see that it depends only on the lines which we called assumptions and on our rules of valid inference. Consider the following argument:[148]

> Holmes will solve the murder only if he consults with Mycroft. However, he will consult with Mycroft if and only if Watson has deserted his post, or Lestrade is on vacation. Lestrade is not on vacation, and Holmes will solve the murder. Therefore, Watson has deserted his post.

The conclusion is obviously 'Watson has deserted his post'. All the other statements are premises, since there are no irrelevances. Let:

P = Holmes will solve the murder

Q = He (Holmes) consults with Mycroft

R = Lestrade is on vacation

S = Watson deserted his post

148 Thanks to N. Scott Arnold, from a brief set of exercises prepared for Rhetoric 100E by Jon Nordby and N. Scott Arnold.

The argument can be translated as follows:

1.	$P \supset Q$	A
2.	$Q \equiv (S \vee R)$	
3.	$\sim R \cdot P$	A
4.	P	3, .E
5.	Q	1, 3, $\supset$E
6.	$S \vee R$	5, 2, $\supset$E
7.	$\sim R$	3, .E
8.	S	7, 6, VE.

We see that 7 depends on 3, and 6 depends on 5 and 2, and that 6 in turn depends on 1 and 3, so the conclusion 8 depends on 1, 2, and 3.

Models

1. In working proofs, you must explain the strategy you follow clearly. These proofs are sometimes best worked backwards. You may now use the same arguments that you provide truth table tests for, and use the rules to prove that the valid ones are valid. Show why the invalid ones cannot be proven, i.e., that reaching the conclusion involves violating one or more of these rules. Explain such violations clearly. You may, if the class is more advanced, introduce alternative proof procedures, such as the Montique and Kalish show line boxing and canceling method.

2. Use the complex argument that you used as an exercise in Subsection 5 and prove that it is valid using these rules, again explaining the strategy to follow.

3. Work proofs involving subproofs for $\sim$ I and $\supset$ I. Explain the nature of these subproofs, explain the nature of the rule of assumption and reiteration as used to bring a previous line into a subproof. Explain the restrictions.

4. Work translations and proofs from the logic texts using these rules - explain the strategy for proving them. Explain the virtue of working backwards from the conclusion to be derived in this particular method.

5. Again, emphasize the usefulness of this for presenting arguments, organizing writing, as well as critically evaluating arguments.

Exercises

1. Start with simple proofs, have them work them, applying the rules. The logic texts are a good source for examples, or you may formulate as well as prove them yourself from Berlitz or VonDäniken have them translate them as well as prove them. Make sure all are in fact, valid. This avoids confusing their inability to master the rules with the impossibility of correctly proving an invalid argument valid.

2. Present more complex arguments, same as 1.

3. Have them write a refutation of some obviously false claim in a book, and use a valid deductive argument form to organize their writing.

Subsection 9 - Evaluating Arguments: PC

We now have a simple procedure for testing an argument for validity (the truth table method) and a proof procedure not only for testing an argument for validity, but also for proving that a conclusion validly follows from given assumptions. We now, given the notions of validity and soundness, have a means to evaluate deductive arguments like A.1.

If the argument is valid <u>and</u> if it is sound, then we know that the conclusion must be true. However, if it is valid and unsound, we do not have any guarantee that the conclusion is true, nor do we have any guarantee that the conclusion is false. If the argument is invalid, then we face a similar situation regarding the truth of the conclusion as when the argument is valid but unsound. Therefore, to evaluate an argument like A.1, we must consider both its validity and soundness.

We have shown that A.1 is valid. However, is it sound? The answer is clearly no. Premise 1 is false and premise 2 is false. We see that both 1 and 2 of A.1 are assumptions from which the conclusion is said to follow. Therefore, since 1 and 2 are false, this valid argument does not establish the truth of the conclusion. Therefore, we are entitled to reject the argument as a failure.

From this we can see that valid arguments must have true premises (that is, they must also be sound) before they may be said successfully to establish the truth of the conclusion. Therefore, to evaluate arguments like A.1 in which the conclusion is said to follow deductively from the premises, we must consider the validity of the argument and the soundness of the argument.

Models

1. Consider many arguments from the reading, formulate them as deductively valid arguments in class, then evaluate them. If you construct them on behalf of an author like Von Däniken or Berlitz, or on behalf of a pseudo-scientist in Gardner, make sure you construct a valid argument. Prove that it is valid, then evaluate its soundness. This will anticipate the ability to reconstruct arguments for evaluation in Section Three.

2. Point out the relations among states of affairs, statements, propositions, and truth values. For the more advanced and curious, this is a good opportunity to introduce theories of truth, and a little metaphysics. Resist the temptation unless the class has the material clearly under control.

Exercises

1. Present them with arguments for evaluation. If you use arguments from logic texts, give them in English so they must translate. Also, you might tell them "What the world is like" for the context of the argument in question, so they can evaluate its soundness.

2. Have them write an evaluation of some pseudo-scientific argument in which they use a deductively valid, and sound argument to organize their evaluation.

Subsection 10 - Logical Form of Statements With Terms: Quantification LPC

So far, we have considered the logical form of complex statements formed by relating simple statements with the logical connectives. However, there are many simple logically valid inferences for which the above tests of validity and proof procedures are inadequate. Consider the following example:

10.1

1. No pseudo-scientists are cautious.
2. Some Americans are pseudo-scientists.

∴ 3. Some Americans are not cautious.

To translate 10.1 into PC will be of no help:

10.2

1. P
2. Q

∴ 3. R

What are logically related in 10.1 are not statements at all, but what we shall call terms, or predicates. So far, we have considered the logical structure of complex statements composed of the logical connectives and simple component statements. These simple component statements were the smallest logical unit. Now to determine the validity and soundness of arguments like 10.1, we must consider breaking down these component statements in turn into their components, namely terms.

Again, all valid arguments depend for their validity on their logical form as defined by our rules of valid inference. However, the arguments may be either composed of the logical relations among complex statements composed of simple statements, or composed of the logical relations among the terms composing the statements.

Statements are either true or false. Terms are true of many objects, one object, no object, and false of all the other objects. For example, the term 'American' is true of each American, and false of each Canadian. We shall call the set of all the objects (in a broad sense) of which a term is true the extension of the term. Thus, the extension of the term 'American' is the set of all Americans. Terms are said to have extensions, just as statements are said to have truth values.

Consider 10.1. 'Pseudo-scientist' is a term that is true of each pseudo-scientist. 'Cautious' is a term that is true of each cautious thing, and as we have seen, 'American' is a term true of each American. Let:

F = 'Pseudo-scientist'

G = 'Cautious'

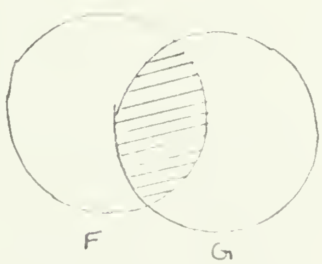
H = 'American'

We may then capture the logical form of 10.1:

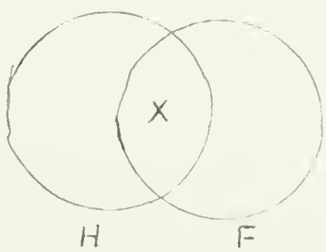
10.3

1. No F are G
2. Some H are F
∴ 3. Some H are not G

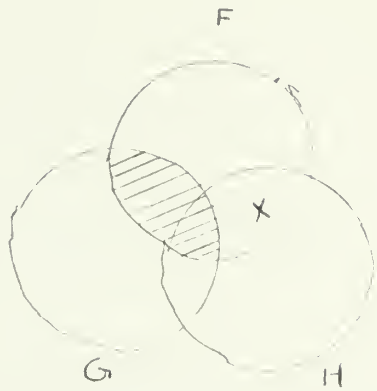
We may use a method invented by a man named Venn (1880) to show the logical relation among the premises and conclusion of 10.3. Let three overlapping circles stand for the extensions of the terms. Let shading stand for emptiness and let 'X' stand for the presence of an object or objects. Thus, we may picture premise 1 as:



and premise 2 as:



We may combine these circles and simply read the results to see if 3 follows given 1 and 2:



We see that the X is not in G, therefore, this pictures a valid conclusion; some H are not G.

The Venn diagram method for determining the validity of arguments like 10.1, however, becomes extremely cumbersome when we have four or more terms. We shall therefore simply adopt the rules we have provided so far for PC and add four new rules to deal with such arguments composed of statements which depend upon the logical relations among terms. The result we shall call LPC; PC standing for propositional calculus, and LPC standing for the lower predicate calculus. ('Predicate' is another word for 'term'.)

Models

1. Point out and explain why the rules of PC are all incorporated into LPC. Explain 'term' and 'predicate', distinguishing them by examples from grammatical 'predicates'. Give examples of arguments from the reading which employ 'all', 'some', and terms in logical relation. Emphasize their difference from arguments using simple statements and complex statements composed of simple statements and the logical connectives.

2. Go through all the common 'syllogisms' using Venn diagrams to show that the conclusion is valid. Include some invalid arguments. Show by using Venn diagrams that the conclusion is not validly reached. (See Quine, especially.)

3. Present an argument using four or more terms, showing how the Venn diagram method, like the method of truth tables, becomes cumbersome and needlessly complex.

4. Here is a good point to introduce the notion of classes and the notion of a set as a kind of class to the more advanced students.

Exercises

1. Have the students diagram a number of syllogistic arguments, showing that they are valid or invalid.

2. Have them, in a specific reading assignment in Gardner, or Von Däniken, reconstruct such an argument, and diagram its validity.

Subsection 11 - Quantifer Rules

What we shall call the existential quantifier, written '$(\exists x)$', corresponds to the words 'there is something x such that', where x is a variable referring to objects in a given domain, or set of objects. For example, consider a statement using the term 'American': 'There are Americans'. This may be written '$(\exists x)(Ax)$', where A is what we shall call a predicate constant standing for 'American'. We know that terms are true of objects; that 'American' is true of each American and false of each non-American.

Intuitively, this allows us some insight into the existential quantifier. Existential quantifiers may be understood in terms of what we may call a domain of objects and disjunction. $(\exists x)(Ax)$ then, can intuitively be seen as a disjunction picking out each object in the world, represented by natural numbers (0, 1, 2 . . . ω; $A1 \vee A2 \vee A3 \ldots \vee A\omega$). Recall that a disjunction is true, just in case one of the disjuncts is true. Therefore, we can see that $(\exists x)(Ax)$ will be true just in case there is at least one American in the world.

What we shall call the universal quantifier, written '$(\forall x)$', corresponds to the words 'each thing x is such that', where x is a variable referring to objects in a given domain. For example, consider a statement using the terms 'American' and 'mortal'; 'All Americans are mortal'. This may be written $(\forall x)(Ax \supset Mx)$, where A is a predicate constant standing for 'American' and M is a predicate constant standing for 'mortal'. Again, since we know that terms are true of objects, we may gain some intuitive insight into the universal quantifier.

For our purposes, universal quantifiers may be understood in terms of a finite domain of objects and conjunction. $(\forall x)(Ax \supset Mx)$, then, can intuitively be seen in terms of a conjunction; picking out each object in the finite domain, represented by letters a, b, c, . . . etc.: $Aa \supset Ma \,.\, Ab \supset Mb \,.\, Ac \supset Mc \ldots Az \supset Mz$. Recall that conjunction is true just in case all the conjuncts are true. Also recall that a conditional is false just in case the antecedent is true and the consequent is false.

We shall now consider 10.3 and see how we can use these quantifiers to capture its logical form. Premise 1 may be written '$(\forall x)(Fx \supset \sim Gx)$', capturing the claim that 'each thing x in the domain is such that if it is F, then it is not G.

Premise 2 can be written '$(\exists x)(x \,.\, Fx)$', capturing the claim that 'there is something x such that it is H and it is F. The conclusion 3, may be written '$(\exists x)(Hx \,.\, \sim Gx)$', capturing the claim that 'there is something x in the domain such that it is H and not G. Therefore, 10.1 may be written as follows:

11.1

$$
\begin{array}{lll}
 & 1. & (\forall x)(Fx \supset \sim Gx) \\
 & \underline{2.} & (\exists x)(Hx \,.\, Fx) \\
\therefore & 3. & (\exists x)\quad(Hx \,.\, \sim Gx)
\end{array}
$$

It is evident that we now need to add to our set of rules some rules of valid inference for the existential and universal quantifier so we can determine the validity of 11.1 given these rules.

Consider the existential quantifier. Existential quantifier introduction, written EQI, allows the following valid inference:

$\underline{1.}$ Aa
2. $(\exists x)(Ax)$

(Where there is an object, represented by 'a' here, in the premise for every X in the conclusion.) This is a valid move because if, for example, 'Joe is an American' is translated 'Aa', where a is a constant referring to Joe, then it is true that there is something that is an American, namely Joe. Existential quantifier elimination, written EQE, is slightly more complex and requires a special kind of what we have called, in the case of $\sim$ I and $\supset$ I, a subproof.

Consider the following simple arguments:

11.2

A. $\underline{1.}$ $(\exists x)(Fx \cdot Gx)$
:. 2. $(\exists x)(Fx)$

B. $\underline{1.}$ $Fa \cdot Ga$
:. 2. Fa (.E)

In 11.2 A., we cannot simply use .E to break up 1, as we do in 11.2 B., since what we shall call the scope of the quantifier ranges over both F and G. Therefore, somehow we must eliminate the quantifier to allow us to apply .E like in 11.2 B. Clearly, if we can get Fa, as in 11.2 B., then we can get $(\exists x)(Fx)$ simply by EQI. To get $(\exists x)(Fx)$ in 11.2 A., we shall use what we shall call a strict subproof. The intuition here is that if $(\exists x)(Fx \cdot Gx)$ is true, then there must be some object in the domain that is both F and G. Let us call that object 'a'. However, it may not be 'a' (i.e., it may be 'b', or 'c'); so we do not want anything in the argument to depend on its being 'a'. This subproof is strict with respect to 'a' in that it must contain no assumptions depending on a and must not contain 'a' in the last line of the subproof. This guarantees that 'a' has no logical relations among any of the premises outside the strict subproof.

In this sense, then, a strict subproof is a model; nothing in the proof depends on picking the correct object in the domain; whatever the correct object is, we can show that the logical relations hold. EQE allows the following valid inference. One may eliminate an existential quantifier by forming a strict subproof with respect to some constant, such that the subproof does not contain that constant in the last line of the subproof and such that the last line of the subproof is validly reached by our rules and one may bring the last line of the strict subproof out of the strict subproof. Consider the following simple proof of 11.2 A. involving EQE and a subproof strict with respect to 'a'.

11.2'

1.	$(\exists x)(Fx \cdot Gx)$	A
a 2.	$Fa \cdot Ga$	1, for EQE
3.	Fa	2, .E
4.	$(\exists x)(Fx)$	3, EQI
5.	$(\exists x)(Fx)$	2-4, 1, EQE

Consider the Universal Quantifier. Universal Quantifier elimination, written UQE, is very simple, and allows the following valid inference:

$$\frac{1.\quad (\forall x)(Fx \supset Gx)}{2.\quad Fa \supset Ga}$$

(Where 'a' is a constant referring to objects in the domain.) This is a valid move because if, for example, everything, if it is F then it is G, then some particular thing, call it a, if it is F then it is G.

Universal quantifier introduction, written UQI, is, like EQE, slightly more complex and requires another subproof, strict with respect to some constant. Consider the following simple arguments:

11.3

A. 1. $(\forall x)(Fx \supset Gx)$
2. $(\forall x)(Bx \supset Hx)$
∴ 3. $(\forall x)(Fx \supset Hx)$

B. 1. $Fa \supset Ga$
2. $Ga \supset Ha$
∴ 3. $Fa \supset Ha$ $\supset$E and $\supset$I

In 11.3 A., we cannot simply use $\supset$E and $\supset$I to reach the conclusion $(\forall x)(Fx \supset Hx)$ since the scope of the quantifiers covers both $Fx \supset Gx$ and $Gx \supset Hx$. We can use UQE to validly conclude $Fa \supset Ha$:

→ 3.	Fa	A
4.	$Fa \supset Ga$	1, UQE
5.	$Ga \supset Ha$	2, UQE
6.	Ga	3, 4, $\supset$E
7.	Ha	5, 6, $\supset$E
8.	$Fa \supset Ha$	3, 7, $\supset$I

The problem remains going from one particular object a if it has F then it has H, to every object in the domain, if it has F, then it has H. The next line in our proof must be:

9. $(\forall x)(Fx \supset Hx)$

But how do we justify such a step?

First, we must notice that nothing in the proof depends on our choosing 'a'; we might just as easily have chosen 'b' or 'c'. This series of steps, 3 through 8, is a model for all the constants in the domain. Therefore, we may take ourselves as having proven all substitution instances, providing that we specify successful guidelines for such a procedure. These guidelines involve introducing a subproof, strict with respect to some constant.

We can now see that UQI allows the following valid inference: from a subproof containing no assumption about a constant c, strict with respect to c, and not containing c in the last line, one may validly infer the universal quantification of the result of replacing every occurrence of c by a variable. Consider the following simple proof of 11.3 A. involving UQI and a subproof strict with respect to 'a':

11.3'

	1.	$(\forall x)(Fx \supset Gx)$	A
	2.	$(\forall x)(Gx \supset Hx)$	A
a	3.	Fa	A
	4.	$Fa \supset Ga$	1, UQE
	5.	$Ga \supset Ha$	2, UQE
	6.	Ga	3, 4, $\supset$E
	7.	Ha	5, 6, $\supset$E
	8.	$Fa \quad Ha$	7 $\supset$I
	9.	$(\forall x)(Fx \supset Hx)$	1, 2, UQI

Finally, it is important to note certain logical equivalences between the existential and the universal quantifier. Using 'Fx' to mean 'x is an F', then $(\exists x)(Fx)$ means: 'there are F', 'some things are F', 'F exists', and therefore, its negation, '$\sim (\exists x)(Fx)$' means: 'there are no F', 'nothing is an F', 'F do not exist'. But to say 'there are no F' is the same as saying 'everything is non-F'. Thus we have two logically equivalent ways of saying 'there are no F'.

(i) $\sim (\exists x)(Fx)$ and
(ii) $(\forall x) \sim (Fx)$

Similarly, $(\forall x)(Fx)$ means: 'all is F', 'each thing is an F', 'everything is an F', 'there is nothing but F', and, therefore, its negation, $\sim (\forall x)(Fx)$' means: 'not everything is an F', 'there are non-F', which is logically equivalent to $(\exists x) \sim (Fx)$. Thus, '$\sim (\forall x)$' is logically equivalent to '$(\exists x) \sim$' and '$\sim$ (x)' is logically equivalent to '$(\forall x) \sim$.'

Therefore, we may translate universal quantifications of the form '$(\forall x)(Fx)$' into the logically equivalent existential quantification '$\sim (\exists x) \sim (Fx)$'. We may translate existential quantifications of the form '$(\exists x)(Fx)$' into the logically equivalent universal quantification '$\sim (\forall x) \sim (Fx)$'. The decision can be based on convenience. To justify such a step in a proof we may simply write 'DM'.

Models

1. Translate many quantifier statement arguments into LPC, use the rules and the proof procedure to prove their validity. (Construct your own from the reading, or use examples provided in the logic texts.) Use quantifier logical equivalences, explain their use in the proof procedure, explain the strategy of sub-proofs and working backward from the conclusion, via the rules. Show how the conclusion depends only on the given assumptions in a valid argument.

2. Reemphasize the material covered in Subsection 4 regarding validity, and relate it to these arguments. Point out the usefulness of these logical tools both for evaluating the validity of complex arguments and also for presenting original arguments, especially critical arguments. Reemphasize the material covered in Subsection 4 regarding soundness.

Exercises

1. Have the students translate any quantifier statement-arguments into LPC, and use the rules to prove their validity.

2. Construct one such argument from the reading, and have them use the rules to prove its validity, and then have them evaluate its soundness.

3. Have an argument from the reading for the students critically to evaluate. Have them organize their evaluation in terms of a quantifier statement argument.

Subsection 12 - Relations

Quantification will not only help us capture and evaluate the logical form of terms in statements, but it will also help us capture the logical form of statements such as 'Berlitz and VonDäniken are acquainted'. This is not a conjunction or any other truth function of the statements:

(i) 'VonDäniken is acquainted', and
(ii) 'Berlitz is acquainted'

The point is not that VonDäniken and Berlitz have a certain property, but that they have a certain relation. Terms such as 'acquainted', 'small', 'between', 'loves', 'hates', etc. are often called relative terms, or relations, because they depend for their evaluation in a particular context on the objects that are related. Furthermore, relations may relate more than two objects. For example, 'New Haven is between New York and Hartford'. However, for the most part, we shall simply consider relations between two objects, called dyadic relations.

Before discussing properties of relations, and their role in arguments, we must see how to capture their logical form. Once we see this, we shall be able to use our rules of valid inference to construct and evaluate proofs containing relations. We have seen that to symbolize 'Joe is an American', we may use a constant, like a letter assigned to Joe in the domain and write 'Aa' or 'Aj'. This is simply what we call a substitution instance of 'x is an American', written 'Ax'. Similarly, when we say that 'Berlitz is acquainted with VonDäniken', this can be regarded as a substitution instance of 'x is acquainted with y'. We must pick a relation constant that does not conflict with predicate constants in an argument. For example, if we chose 'A' to stand for 'is acquainted with' in an argument where 'A' already stood for 'American', confusion would result. Thus, care must be taken in symbolizing statements, terms and relations. Let's let 'B' stand for 'is acquianted with'. 'X is acquainted with y', then, can be written 'Bxy'. Similarily, 'Berlitz is acquainted with VonDäniken' can be written 'Bbv', where 'b' is a constant referring to Berlitz and 'v' is a constant referring to VonDäniken.

The order of replacement is very important. For example, if it is true that Berlitz is, in fact, acquainted with VonDäniken, then it may not be true that VonDäniken is acquainted with Berlitz. This is so because of various properties relations have, as we shall see in a moment. So 'Bbv' may be true, but 'Bvb' may be false. These are clearly not logically equivalent.

Consider some simple relations and their correct translation:

Everything attracts everything	$(\forall x)(\forall y)(Axy)$
Everything is attracted by everything	$(\forall y)(\forall x)(Ayx)$
Something attracts something	$(\exists x)(\exists y)(Axy)$

Such relations have many interesting properties. First, they may be characterized as symmetrical, asymmetrical, or non-symmetrical. A symmetrical relation = def if one individual has it to a second, then the second must have it to the first. 'Rxy' designates a symmetrical relation if and only if $(\forall x)(\forall y)(Rxy \supset Ryx)$, i.e., "is next to," "is married to." An asymmetrical relation = def if one individual has it to a second, then the second cannot have it to the first. 'Rxy' designates an asymmetrical relation if and only if $(\forall x)(\forall y)(Rxy \supset \sim Ryx)$, i.e., 'is north of', 'is older than'. A non-symmetrical relation = def a relation that is neither symmetrical or asymmetrical.

Secondly, they may be characterized as transitive, intransitive, or non-transitive. A transitive relation = def if one individual has it to a second, and the second to a third, then the first must have it to the third. 'Rxy' designates a transitive relation if and only if $(\forall x)(\forall y)(Az)[(Rxy \; . \; Ryz) \supset Rxz]$, i.e., 'is the mother of', 'is the father of'. An intransitive relation = def if one individual has it to a second, and the second to a third, then the first cannot have it to the third. 'Rxy' designates an intransitive relation if and only if $(\forall x)(\forall y)(\forall z)[(Rxy \; . \; Ryz) \supset \sim Rxz)$, i.e., 'is the mother of', or 'is the father of', etc. A non-transitive relation = def a relation which is neither transitive nor intransitive, i.e., 'loves'.

Thirdly, they may be characterized as totally reflexive, reflexive, irreflexive, or non-reflexive. A totally reflexive relation = def every individual has it to himself. 'Rxy' designates a totally reflexive relation iff $(\forall x)(Rxx)$, i.e., 'is identical with'. A reflexive relation = def one individual, a, has that relation to itself if something, b, is such that either Rab or Rba. 'Rxy' designates a reflexive relation iff $(\forall x)(\forall y)[(Rxy \vee Ryx) \supset Rxx]$, i.e., 'is same age as', 'has same color hair as' (obviously all totally reflexive relations are reflexive). An irreflexive relation = def no individual has it to himself. 'Rxy' designates an irreflexive relation iff $(\forall x) \sim (Rxx)$, i.e., 'is north of', 'is married to'. A non-reflexive relation = def a relation that is neither totally reflexive, reflexive, or irreflexive.

Clearly, relations may have various combinations of properties described. For example, the relation of 'weighing more than' is symmetrical, transitive, and irreflexive, while the relation of 'having the same weight as' is symmetrical, transitive and reflexive. Relations enter into arguments in many ways, as we shall see. However, there is one relation, namely identity, which is important enough to consider alone.

Models

1. Show very carefully how relations enter into arguments, and their translation into LPC. This involves presenting many arguments using relations. (Consult logic texts.)

2. Define and explain very carefully the notion of an <u>enthymeme</u>. Construct, using relations, several enthymemes in which the missing premise is a statement of a relation. Then consider other <u>enthymemes</u> from the reading, supplying the implicit premise to make the argument valid. This is a good place to introduce the principle of charity.

Exercises

1. Have the students name the following dyadic relations, i.e., 'equals' - trans, symm, reflexive.

   is not less than
   is greater than or equal to
   is the successor of
   is a predecessor of
   is congruent with
   is fond of
   is the spouse of
   defeats the brother of
   is the uncle of
   is the brother of
   is the sibling of
   is logically equivalent to
   is the friend of
   is north of
   is hungry for
   loves the wife of
   is next to
   defeats
   is on the right of
   is the square root of
   is sour as
   is compatible with
   logically implies

2. Have the students prove the following about relations:

   totally reflexive $\supset$ reflexive
   asymmetrical $\supset$ irreflexive
   intransitive $\supset$ irreflexive
   (transitive and irreflexive) $\supset$ asymmetrical
   (transitive and symmetrical) $\supset$ reflexive
   (intransitive . symmetrical) $\supset$ irreflexive
   reflexive $\equiv$ $(\forall x)(\forall y)(Rxy \supset (Rxx \,.\, Ryy)$
   $\sim$ $(\exists x)(\exists y)(Rxy)$ $\supset$ (symmetrical . asymmetrical)

3. Have them symbolize and deduce a contradiction from: There are two different things each taller than anything different from it. (Note - this is an enthymeme.)

Subsection 13 - Identity and Definite Descriptions

Many arguments depend for their valid logical form on the identity of an object. For example, consider:

1. Lewis Carroll was Charles Lutwidge Dodgson.
2. Lewis Carroll was an author.

∴ 3. Charles Lutwidge Dodgson was an author.

The usual notation for identity is '='. It is obvious that identity is transitive, symmetrical, and totally reflexive. In our symbolic notation:

(i) Transitive: $(\forall x)(\forall y)(\forall z)(((x = y) \cdot (y = z)) \supset (x = z))$

(ii) Symmetrical: $(\forall x)(\forall y)((x = y) \supset (y = x))$

(iii) Total reflexivity: $(\forall x)(x = x)$

We may, therefore, introduce a rule, for convenience, called identity introduction, written = I. We can see that x = y iff every property of x is a property of y, and every property of y is a property of x. Given the second half of this biconditional = I allows us validly to conclude that x = y, i.e., that x and y refer to one object. Identity elimination, written = E, allows the following valid inference, based upon the same biconditional:

$$\begin{array}{ll} 1. & x = y \\ \underline{2.} & Fx \\ \therefore\ 3. & Fy \quad (= E) \end{array}$$

Identity has other uses in arguments. It allows us both to capture the logical form of certain exceptive statements and what are called definite descriptions. Consider a statement like "Bill is on the Green Bay Packers and can out-run any-one else on it'. Using b for Bill, Gx for 'x is on the Green Bay Packers' and 'Oxy' for 'x can out-run y', we cannot capture this by $Gb \cdot (\forall x)(Gx \supset Obx)$ because this entails Obb, which is false because being able to outrun is an irreflexive relation. Thus, this translates the false statement 'Bill is on the Green Bay Packers and can outrun anyone on it'. The word 'else' is missing. The proper translation appeals to identity: $Gb \cdot (\forall x)((Gx \cdot \sim (x = b)) \supset Obx)$. Consider statements containing 'at most' and 'no more than'. For example, 'there is at most one explanation'. This does not say that there <u>is</u> an explanation, only that there is no more than one. Again, the proper translation appeals to identity: $(\forall x)(\forall y)((Ex \cdot Ey) \supset x = y)$. Similarly, the statement 'there are not more than two explanations' leaves open the question of there being any at all: $(\forall x)(\forall y)(\forall z)((Ex \cdot Ey \cdot Ez) \supset (x = z) \vee (y = z) \vee (x = y))$.

Identity is also useful for capturing the logical form of statements containing 'at least'. It is not needed for 'at least one', since the existential quantifier alone handles this case. However, consider the statement 'there are at least two explanations'. Using identity, the proper translation is: $(\exists x)(\exists y)(Ex \cdot Ey \cdot \sim (x = y)$.

We may also combine the translations for 'at least one' and 'at most one' to develop a method for symbolizing definite numerical propositions. Thus, the statement 'there is one correct explanation', meaning exactly one, is translated: $(\exists x)\ (\forall y)((Ey \cdot Cy) \equiv y = x))$. The statement 'there are two probable causes', meaning exactly two, is translated: $(\exists y)(\exists z)((Cy \cdot Cz \cdot \sim (y = z)) \cdot (\forall x)(Cx \supset (x = y) \vee x = z)))$.

We may also use identity to translate what have been called definite descriptions. Consider the following statement: 'The author of De Motibus Stellae Martis is a genius'. This statement seems to assert first, that there is some individual who wrote De Motibus Stellae Martis, second, that at most, one individual wrote it, and third, that that individual was a genius. Using 'm' to represent 'De Motibus Stallae Martis', 'G' to represent 'genius', and 'W' for 'wrote', each of these may intuitively be translated as follows:

(i) $(\exists x)(Wxm)$ ·
(ii) $(\forall y)(Wym \supset y = x)$.
(iii) Gx

Combining these, we get the correct translation of such a definite description: $(x)(Wxm \cdot (\forall y)(Wym \supset x - y) \cdot Gx)$.

Models

1. Point out that two objects are not identical, and explain why. Distinguish identity and similarity via properties.

2. Present and translate statements of the forms considered here - at least two, at most one, exactly one, etc. - using identity. Such statements may come from the reading (Gardner).

3. Consider and discuss the notion of the scope of quantifiers.

4. Translate and discuss various define descriptions, used in the various explanations mentioned by Gardner. Consider the problem of non-denoting definite descriptions and Russell's proposed solution. Resist the temptation to present too many metaphysical complications. However, this is a good point to introduce the notion of an ontology.

5. Reemphasize the interpretations of the quantifiers in terms of a domain and disjunction $(\exists x)$ and a domain and conjunction $(\forall x)$.

Exercises

1. Have the students translate statements like the following, using identity:

   a) There is at least one person, but everyone has at most one father.
   b) At most two robbers held up the store.
   c) One and only one man issued the invitation to at most two men.
   d) No one but John or Bob has the keys.

e) Distinct men have distinct wives.
f) A function is one-one if and only if each of its values is the value for a unique argument.

2. Have them translate and prove the validity of arguments like the following, using identity:

   a) Honolulu's mayor is a native of Hawaii. Hence, some mayor is a native of Hawaii.
   b) The fastest horse in the race is a thoroughbred. Thus, if at least two horses are in the race, then some thoroughbred is faster than some other horse.
   c) The ugliest monarch was British. All British kings are dead, and all male monarchs are kings. Thus, if the ugliest British monarch was male, then the ugliest monarch is dead.

3. Find other exercises in the logic texts.

Subsection 14 - Summary of the Rules of Valid Inference

We now have the logical tools to capture the logical form of most ordinary deductive arguments. We shall now summarize the rules of valid inference for convenience, and then work some proofs to become familiar with their operation. The rules we have are as follows:

(1)	$\sim$ I $\sim$ E	(6)	R
(2)	.I .E	(7)	A
(3)	vI vE	(8)	UQI UQE
(4)	$\supset$I $\supset$E	(9)	EQI EQE
(5)	$\equiv$ I $\equiv$ E	(10)	DM
		(11)	= I = E

Note that all the rules for PC apply to LPC.

Models

1. Go over the exercises, translations and proofs assigned in Subsection 13, and work them in class. Work any other exercises that raise questions or problems.
2. Explain, in the form of a review, the value of such proofs, the value of translation into our symbolic notation, and the practical applications of this in terms of evaluating arguments and organizing writing.
3. Note that we cannot as yet deal with modal arguments, or some moral arguments - that our translations have limits. Note also that we cannot capture the forms of arguments like A.2.

Exercises

1. Have the students work more problems, assigned from the reading or taken from logic texts.
2. Have the students evaluate the form of the explanations presented by Gardner on behalf of the pseudo-scientists. What would the advantage be if the explanations were supported by valid deductive arguments?

Subsection 15 - Proofs of Deductive Validity: LPC

Given these rules and the ability to translate arguments into LPC symbols, we must now apply our proof procedure from Subsection 8. Consider the following argument:

> The professor of Greek at Siwash is very learned. Therefore, all professors of Greek at Siwash are very learned.
>
> Let Px = x is a professor of Greek, Sx = x is at Siwash, Lx = x is very learned.

The proof, with translations and justifications, appears as follows:

1.	$(\exists x)(Px \,.\, Sx \,.\, (\forall y)(Py \,.\, Sy \supset x = y) \,.\, Lx)$	A
2.	$Ia \,.\, Sa$	A
3.	$(Pb \,.\, Sb \,.\, (\forall y)(Py \,.\, Sy \supset b = y) \,.\, Ib$	1, for EQE
4.	$(Pa \,.\, Sa) \supset b = a$	3, UQE
5.	$Pa \,.\, Sa$	2, R
6.	$b = a$	4, 5, $\supset$E
7.	Lb	3, .E
8.	La	6, 7, =E
9.	La	EQE
10.	$(Pa \,.\, Sa) \supset La$	2, 9, $\supset$I
11.	$(\forall x)((Px \,.\, Sx) \supset Lx)$	10, UQI

The strategy here, as pointed out in preceding models, is to work backwards from the conclusion, anticipating the rule needed to derive what is required to get each line.

Models

1. Work more difficult translations and proofs, again clearly explaining the proof procedure as you proceed. This may take the form of a review.

2. Again, explain the use of this, using the final exercise from Subsection 14 as a basis for discussion. Note the value of clarity in the process of evaluation.

Exercises

1. Provide a representative sample of proofs, ranging from PC proofs to difficult LPC proofs. Have the students work these proofs, making sure to justify each line according to our proof procedure.

2. Have the students evaluate the strengths and weaknesses of the proof procedure. What makes it hard? What makes it easy? Why? What makes it useful, and why? What are the limits of its use, and why? Point out other proof

procedures, and discuss their merits and defects. In more advanced sections, this a good place to discuss completeness.

Subsection 16 - Evaluating Arguments: LPC

We now have a method for translating relatively complex arguments into LPC and proving them valid. Again, given a valid argument, we must check to see if it is also sound. Note that the truth value of a quantified statement depends on no more than the extension of the statement under the quantifier: an extential quantification is true or false according to whether its extension is not empty or empty, and a universal quantification is true or false according to whether its extension exhausts the universe or not.

Models

1. Discuss the assignments of truth values to quantified statements, recalling our intuitive picture of the quantifiers.

2. Discuss the soundness of various valid arguments for the purposes of evaluation.

3. Review 'states of affairs' and 'truth' and a simple view of theories of truth.

Exercises

1. Have the students evaluate the soundness of various valid LPC arguments. (You might consider describing a world for the purposes of providing a context for the argument.) Have them come up with truth conditions for various quantified statements and compare the assignments with the stipulated world.

2. Have the students write a brief essay describing the uses of this material, and limits to the use of this material. Have them use the form of a valid deductive argument to present their essay. (These may be used as discussion material to lead into a consideration of inductive arguments.)

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Section Two: Inductive Arguments and Their Evaluation

Subsection 1 - Distinction Between Deductive and Inductive Arguments

We now have a means of capturing the logical form of complex statements composed of simple component statements and the logical connectives, as well as complex statements composed of terms, relations and 'all' or 'some' quantifiers. In so capturing this logical form we also have a means for capturing the logical form of deductive arguments and evaluating them by determining their validity and soundness. However, there are some arguments, like A.2, for which the above mentioned evaluating techniques are inadequate. While we may capture the logical form of the statements composing A.2, the logical relations among such statements are not truth-functional logical relations. Such arguments are never deductively valid because they are not deductive arguments. Arguments like A.2 rely on a totally different sort of "following from" when we say that "conclusions follow from the premises" of such arguments. These are called inductive arguments.

In deductive arguments we said that true premises in a valid deductive argument form guarantee the truth of the conclusion. Thus, valid sound deductive arguments provide the strongest possible support for their conclusion; they guarantee that they are true. However, in arguments like A.2, the support provided by the premises for the conclusion, even if the premises are true, is not nearly so strong; the support does not guarantee that the conclusion is true. The premises merely provide evidence to support the conclusion. Intuitively we can see that sometimes the premises provide evidence that strongly supports the conclusion, and that sometimes the premises provide evidence that weakly supports the conclusion.

We can see that inductive arguments do not guarantee the truth of their conclusions by considering the following argument and supposing that the premises are true:

1.1

1. James Earl Ray confessed to killing Martin Luther King.
2. FBI is satisfed that Ray committed the murder.
3. Witnesses placed Ray at the location from which the shots were fired.
4. Ray was tried and found guilty of the murder.

∴ 5. Ray killed King.

Although the premises seem to provide evidence that supports the conclusion, the truth of the premises does not guarantee the truth of the conclusion. This is to say that it is logically possible that the conclusion is false while the premises are true. For example, it is logically possible that Ray confessed for reasons other than his guilt, that the FBI was guilty of some willful or inadvertent oversight, that the witnesses were lying or mistaken, and that relevant evidence was suppressed during the trial. To determine that these logically possible explanations are true, we need to obtain more evidence to support them.

Sometimes the premises provide evidence that strongly supports the conclusion, and sometimes the premises provide evidence that weakly supports the conclusion. Consider the following argument:

1.2

1. Jones' house is three feet from the Raging Mud River.
2. The Raging Mud River flooded its banks 12 feet.

∴ 3. Jones' basement is wet.

We can easily see, given that the premises are true, that the premises of 1.2 provide evidence that is <u>very</u> weak support for the conclusion. For example, from the premises we do not even know if Jones' house has a basement. For all we know, Jones may live in a mobile home, or a houseboat. Furthermore, we do not know when the Raging Mud River flooded its banks twelve feet; it could have been a hundred years before Jones' house was located three feet from this river.

We can see, then, that to provide evidence that is strong support for the conclusion of an inductive argument like 1.2, we must provide more evidence, and that evidence must increase, not decrease, what we shall call the probability that the conclusion is true.

Consider the following argument:

1.3

1. Jones' house is three feet from the Raging Mud River.
2. Jones' conventional house was built in 1965 with conventional methods, and has a conventional basement and is still standing.
3. The Raging Mud River flooded its banks twelve feet yesterday at noon.
4. Jones' family escaped to high ground, and saw their house submerged in the muddy river.

∴ 5. Jones' basement is wet.

We can easily see, given that the premises are true, that the premises of 1.3 provide evidence that is <u>very</u> strong support for the conclusion. We can see, therefore, that the premises of inductive arguments can be said to provide evidence in various degrees of strength when providing evidence to support a particular conclusion. Indeed, such strength may diminish to the point where the premises are irrelevant to the conclusion. We may, therefore, begin to evaluate such inductive arguments by considering the strength with which the premises are said to provide evidence to support the conclusion.

Models

1. Present several other weak inductive arguments from the reading and ask the students to place bets on the conclusions. Then ask them, if they are reluctant to bet, what they want to know before placing the bet. Soon they will catch on to what distinguishes a strong and a weak inductive argument. You may then provide answers to their questions and produce a strong inductive argument.

2. Contrast deductively valid and sound arguments and inductively strong arguments by presenting one of each and then asking them which of the argument's conclusions, the deductively valid and sound or the inductively strong, they would bet their lives is true.

Exercises

1. Have the students verify, using truth tables, that 1.1 and 1.3 are not deductively valid arguments. Given 1.3, have them provide logically possible situations where the premises are true and the conclusion false.

2. Point out the role of evidence and the need for gathering as much evidence as possible, have the students (or a group of them) gather information and attempt to construct a strong inductive argument from 1.1 using either 'Ray killed King' or 'it is not the case that Ray killed King' as the conclusion. This also points out the role of research in inductive argument and the need to appeal to all relevant available evidence, not just selective facts.

Subsection 2 - Possibility Versus Probability: Inductive Strength and the Probability Calculus

We must now more clearly define the notions of "providing evidence which strongly supports a conclusion" and "providing evidence which weakly supports a conclusion." We can see that in 1.2 we need more evidence - more research to provide relevant facts. Now this research may provide relevant evidence that requires us to change the conclusion. For example, we may discover that it is a fact that Jones' house does not have a basement. A fact, for our purposes here, is simply a statement that is true.

But suppose that our research uncovers the facts listed as premises 1, 2, 3 and 4 in 1.3. Since 1, 2, 3 and 4 are facts, by definition we know they are true. We know that the conclusion, 5, is a statement. Therefore, we know that this statement has a truth value since having a truth value is a property of all statements.

The problem, of course, is that knowing that five is either true or false does not help us to decide which truth value to assign to five. Furthermore, we know that 1.3 does not guarantee the truth of the conclusion given true premises, since it is logically possible for the premises to be true and the conclusion to be false. (For example, Jones may have his basement packed solidly with a water repellent chemical which prevents the basement from getting wet.) It is also physically possible for the premises to be true and the conclusion to be false. (For example, packing his basement solidly with such a water repellent chemical does not violate any laws of nature.) We may discover this relevant fact about Jones' basement given further research, and change our decision about which truth value to assign to 5.

What is of interest in argument 1.3 is not the logical or physical possibility of the premises being true and the conclusion false, but the probability of the premises being true and the conclusion false. We may now see that if we have evidence that supports the conclusion, the probability of the conclusion being true given this evidence is greater than the probability of the conclusion being false, given this evidence. That is, we are interested in determining what we shall call the inductive strength of the argument. We can say that the probability of the conclusion being true given the premises is the degree of likelihood that the conclusion is true, given the statement composed of the conjunction of the premises. In the case of 1.3, this can be expressed using the premise numbers as propositional constants, as '5 given 1, 2, 3 and 4'. So we must somehow determine the probability that this is true. If this is more probably true than the denial of the conclusion, given the premises, it is clear that the argument supports its conclusion. If this statement is less probably true than the denial of the conclusion given the premises, it is clear that the argument fails to support its conclusion.

However, we must consider this matter more carefully and precisely define what it is for premises to be evidence for a conclusion and the notion of inductive strength.

Ideally, 'probability' ought to be more precisely characterized. Indeed, there are competing alternative interpretations of this term. Various philosophers have provided alternative interpretations attempting to give a precise meaning to and foundation for 'probability'. Such alternative interpretations have been described under categories such as classical, empirical, logical, subjectivist and epistemological. It is beyond the scope of our interest here to consider this matter. We shall see the importance of such interpretations when we discuss what is called the problem of induction, but both providing such an interpretation of 'probability' and addressing what we shall call the problem of induction are beyond the scope of this course. We shall rely on this intuitive understanding of 'probability' and deem that understanding sufficient for our purposes here.

Practically, we may use part of what is called the probability calculus technically to define the notion of evidence for a conclusion and inductive strength for the purposes of intuitive determinations.

The probability calculus states, in the form of certain definitions, how the probability of a complex statement such as '5 given 1, 2, 3, 4' is related to the probability of its simple constituent statements. Thus, we can see at least a general relation between the probability calculus and the propositional calculus; both relate a property of a complex statement to properties of its simple component statements. However, the probability calculus deals with statement probabilities, while the propositional calculus deals with truth values. Truth value and probability, as we have seen, are very different notions. Yet both the probability calculus and the predicate calculus face a similar problem regarding the assignment of statement probabilities and truth values to the simple component statements; the problem of determining the probability of the simple component statement is not resolved by the probability calculus, just like the problem of determining the truth value of the simple component statement is not resolved by the propositional calculus.

We can, however, begin the assignment of probabilities to statements.[149] If a statement S is a tautology, 'S $\supset$ S'

[149] See Brian Skyrms, Choice and Chance: An Introduction to Inductive Logic, Second Edition, pp. 130-149.

or a logical equivalent, then the probability of S, written P(S), equals 1. If a statement S is a contradiction, 'S · ∿ S' or a logical equivalent, then P(S) = 0. If two statements S and S' are logically equivalent, then they have the same probability, written P(s) = P(S').

Given these assignments of probabilities to statements, we may define other assignments and relationships among statements and their probabilities.[150] However, for our practical purposes here, we shall simply define what we shall call conditional probability as follows:

$$P(q/p) = P(p \cdot q) \div P(p)$$

In English, this says that the probability of q given p equals the probability of p and q divided by the probability

[150] For example, if p and q are mutually exclusive, that is, contrary where not both can be true, or contradictory, then, using a combination of our symbolic conventions for probability, arithmetic, and deductive logic, we shall write $[P(p \vee q) = P(p) + P(q)] - P(p \cdot q)$. In English this says that the probability of p or q equals the probability of p plus the probability of q, the quantity minus the probability of p and q. We may also say that $P(\sim p) = 1 - P(p)$, that is, that the probability of not p equals 1 minus the probability of p. The probability of p and q, written $P(p \cdot q)$, equals $P(p) \times P(q/p)$. In English this says that this equals the probability of p times the probability of q given p. We shall define what we shall call the independence of two statements, p and q, as follows: p and q are independent iff $P(q/p) = P(q)$. If p and q are independent, then $P(p \cdot q) = P(p) \times P(q)$.

of p. The probability of q given p is called a conditional probability.

Given this basic relationship among the assignments of probability to statements, we are now in a position rigorously to define evidence and inductive strength and to consider the inductive strength of 1.3.

We shall define what is to be evidence for a particular conclusion in terms of the conditional probability of the conclusion given the evidence, written P $(C/\emptyset)$, where 'C' is a propositional variable standing for the conclusion and '$\emptyset$' is the variable representing the conjunction of the evidence as premises. Intuitively, if we have evidence $\emptyset$ that supports the conclusion C, the probability of C being true given $\emptyset$ is greater than the probability of $\sim$ C being true given $\emptyset$. Therefore, we can say that in an argument of the form $\emptyset$:. C, $\emptyset$ is evidence for C iff $P(C/\emptyset) > P(\sim C/\emptyset)$.

We shall now define inductive strength in terms of evidence. Intuitively, if we have evidence that supports the conclusion, then the argument is inductively strong. If, on the other hand, we cite premises that are not evidence for the conclusion, then the argument is inductively weak. Since 1 is the highest probability, intuitively we can see that for an argument to be inductively strong, a calculation of the conditional probability of the conclusion given the premises must be closer to 1 than to 0 since an argument is inductively strong iff it is probable that its conclusion is true given the premises. But just what value is that? This is the problem that now arises for our system. For our purposes here, let us say that an argument of the form $\emptyset$:. C is a strong inductive argument iff $P\ (C/\emptyset) > P(\sim C/\emptyset)$. Let us also say that an argument of the form $\emptyset$:. C is a weak inductive argument iff $P\ (C/\emptyset) \leq P(\sim C/\emptyset)$.

We may now more precisely consider whether or not the premises of 1.3 are evidence for the conclusion, and thereby consider the inductive strength of 1.3. If the statement '5 given 1 . 2 . 3 . 4' is more probably true than '$\sim$ 5 given 1 . 2 . 3 . 4', the premises will be evidence for the conclusion and 1.3 will be a strong inductive argument. This is to say that if $P\ (5/1 . 2 . 3 . 4) > P(\sim 5/1 . 2 . 3$ $4)$, then it will be strong, but if $P\ (5/1 . 2 . 3 . 4) \leq$ $P\ (\sim 5/1 . 2 . 3 . 4)$, then the premise do not be evidence for the conclusion, and 1.3 will be a weak inductive argument.

For our purposes here, on this intuitive level, we shall avoid actual calculations and simply appeal to our intuitions to determine whether or not given premises are in fact evidence for the conclusion. This, as we shall see, involves exercising our intuitions for establishing the best explanations relative to a particular set of premises.

In 1.3, the statement '~ 5 given $1 \cdot 2 \cdot 3 \cdot 4$' can be seen to have less probability than the statement '5 given $1 \cdot 2 \cdot 3 \cdot 4$'; it is more likely true than '~ 5 given $1 \cdot 2 \cdot 3 \cdot 4$'. This is to say that $P(5/1 \cdot 2 \cdot 3 \cdot 4) > P(\sim 5/1 \cdot 2 \cdot 3 \cdot 4)$. Therefore, we can intuitively see that the premises of 1.3 provide evidence for the conclusion and that 1.3 is an inductively strong argument.

We can easily see that 1.2 is inductively weak, since, again using the numbers of the premises as propositional constants, '3 given $1 \cdot 2$' is less likely true or has a lower degree of probability than '~ 3 given $1 \cdot 2$'. That is, $P(\sim 3/1 \cdot 2) > P(3/1 \cdot 2)$ or in our terms, $P(3/1 \cdot 2) \leq P(\sim 3/1 \cdot 2)$. Since it is more probable that its conclusion is false given its premises than that its conclusion is true given the premises, the premises of 1.2 are not evidence for the conclusion and 1.2 is a weak inductive argument.

This determination of inductive strength is not affected by the fact that some of the premises are not probable or are, in fact, false. Intuitively, therefore, we can view the notion of inductive strength as a measure of the evidential relation between the premises and the conclusion, much like validity in deductive arguments is a measure of the logical relation between the premises and the conclusion. Therefore, just as valid deductive arguments do not guarantee true conclusions (i.e., if one or more premises are false), so strong inductive arguments do not guarantee highly probable conclusions. Consider the following argument:

2.1

1. There is intelligent life on Mercury.
2. There is intelligent life on Venus.
3. There is intelligent life on Earth.
4. There is intelligent life on Jupiter.
5. There is intelligent life on Saturn.
6. There is intelligent life on Uranus.
7. There is intelligent life on Neptune.
8. There is intelligent life on Plato.

∴ 9. There is intelligent life on Mars[151]

Intuitively, the conclusion of 2.1 is not probable. However, $P\ (9/1 \ .\ 2 \ .\ 3 \ .\ 4 \ .\ 5 \ .\ 6 \ .\ 7 \ .\ 8) > P\ (\sim 9/1 \ .\ 2 \ .\ 3 \ .\ 4 \ .\ 5 \ .\ 6 \ .\ 7 \ .\ 8)$. Therefore, the premises of 2.1 do provide evidence for the conclusion, and 2.1 is an inductively

[151] This argument is from Brian Skyrms, Choice and Chance: An Introduction to Inductive Logic, Second Edition (California: Dickinson Publishing Co., 1975), p. 9.

strong argument. However, the conclusion is intuitively not probable. We must ask, then, under what conditions are the conclusions of inductively strong arguments highly probable?

Models

1. Construct a number of inductively strong arguments using VonDäniken's book Chariot of the Gods, for example, to support the conclusion the pyramids were built by visitors from outerspace. Show that they are inductively strong, given the low probability of the statement formed from the conjunction of the premises (assumed to be true) and the denial of the conclusion. Include as premises obviously false statements about the stupidity of ancient people, etc. Point out the improbable and false premises. Suggest that while the argument is strong, we still need to be able to say that the argument is no good; it fails to support the conclusion.

2. For comparison use the above material and construct valid deductive arguments to support the same conclusions, for example, to support the conclusion 'the pyramids were built by visitors from outerspace'. Prove that they are valid, and show that they are unsound. Suggest that we need something like soundness for inductive arguments.

3. Critically consider VonDäniken's discussion of the "possibility of life" on other planets. Point out the interesting question is the probability of life, not the possibility of life.

4. Stress an understanding of the probability calculus on an intuitive level; "high" and "low" rather than actual calculations. Use examples from Berlitz to construct more inductively strong arguments, and anticipate how we shall appeal to the notion of 'all relevant facts' to avoid the problem of a selective approach to data.

5. Anticipate the problem of assigning precise values to statement probabilities but point out that we can still make such decisions correctly on an intuitive level.

Exercises

1. Have the students attempt to construct a number of inductively strong arguments using VonDäniken's book. For example, arguments about Sodom and Gomorrah, The Ark of Covenant, or the statues on Easter Island. Having done so, ask them to research the claims made as evidence and point out which premises are false and which are improbable. Then ask them to evaluate the support the premises, found in their research to be false, actually give for the conclusions. Have them point out the improper selection of certain true premises which, when added to the argument, affect the probability of the conclusion.

2. Have them reformulate the above arguments into deductively valid arguments. Have them evaluate their soundness, given their research into VonDäniken's claims.

3. Have the students become familiar with these basic concepts of the probability calculus by doing some problems. Given:

   P (p) = 1/2 P (q) = 1/2, p and q are independent,

   a) What is P (p . q)?
   b) Are p and q mutually exclusive?
   c) What is P (p v q)?

   (Consult Skyrms or Cox for other exercises.)

Subsection 3 - Inductive Strength, Inductive Inconsistency, and the Epistemic Probability of Conclusions

We have seen that an inductive argument like 2.1 may be strong, yet we cannot truly assert that the argument's conclusion is highly probable. The conclusion of 2.1 is not probable. We might also know that premises 1, 2, 4, 5, 6, 7 and 8 are not probable. We might think that given an inductively strong argument, we can truly assert that its conclusion is highly probable given that we know the premises to be true, or highly probable. While knowing that the premises of an inductively strong argument are true or highly probable is a necessary condition for establishing the high probability of its conclusion, it is not a sufficient condition. To see that this is so, we must consider what we shall call inductive inconsistency.

Inductive inconsistency arises from what we shall call the problem of the detachment of premises. In inductive logic, we seek to provide premises which are evidence for a conclusion. However, we may willfully or inadvertently select evidence which supports a particular conclusion while ignoring evidence which supports the denial of that conclusion. Thus, the premises we select, even if true, may be detached from the set of relevant evidence which must be considered to arrive at a correct probability for the conclusion.

This detachment of true premises from the set of all relevant true premises gives rise to inductive inconsistency as follows. Suppose in an inductively strong argument A, in relation to true premises $\emptyset$, the conclusion C is highly probable. That is, $P(C/\emptyset) > P(\sim C/\emptyset)$. Furthermore, suppose that, since the premises are true, $P(\emptyset) > P(\sim \emptyset)$. However, in an inductively strong argument B, in relation to true premises ψ, the conclusion $\sim C$ is highly probable. That is, $P(\sim C/\psi) > P(C/\psi)$. Furthermore, suppose that, since the premises are true, $P(\psi) > P(\sim \psi)$. This is called inductive inconsistency because in relation to one set of true premises $\emptyset$, C is probable; in relation to another set of true premises ψ, the conclusion $\sim C$ is probable. We are not justified in asserting that a conclusion is highly probable just given that the premises are true and that the premises provide evidence for the conclusion.

To truly assert that a conclusion of an inductively strong argument has a high probability of being true, we must, therefore, not only require that the premises of the argument be true, or highly probable, but also avoid this problem of detachment. We must be assured that the premises have taken into account all relevant available information. To do so we must require that inductive arguments assign what we shall call epistemic probabilities to their conclusions.

The epistemic probability of a given statement is the conditional probability of the statement given all relevant available evidence. This is written 'P (c/all relevant available evidence)'. We shall, for convenience, abbreviate 'all relevant available evidence' as 'K', thus, this is written 'P(c/K)'. K, for our purposes, is the set of all relevant available evidence such that each member of K is more probable than its negation. The epistemic probability of a statement can vary from person to person and time to time since different people have different evidence available in different amounts at the same time, and the same person has different amounts of evidence available at different times. It follows, therefore, that the epistemic probabilities of certain statements change, given additions to human knowledge and probable truths. For example, the epistemic probability of 'cancer is caused by a virus' is very low, but through advances in cancer research, we may increase our body of evidence about cancer and learn facts that increase the epistemic probability of 'cancer is caused by a virus'. This increase in our body of evidence in turn provides additional premises which affect the inductive strength of the inductive argument having 'cancer is caused by a virus' as a conclusion and all relevant available evidence as premises.

Here it is useful to distinguish the epistemic probability of a statement from the truth value of a statement.

Clearly, since it is a statement, 'cancer is caused by a virus' has a truth value; it is either true or false. However, the problem is that we do not know at this time which truth value to assign to it, although we are inclined to bet more toward false than toward true. We, therefore, are forced into a position in which we must deal with the epistemic probability of the statement; the probability that the statement is true given that the premises are true or highly probable, where the premises are relevant available evidence. In this position, we must remain open to the introduction of new evidence which will affect the epistemic probability of the statement under consideration. We tust remain open to new evidence as it becomes available.

Since the epistemic probability of a given statement S is a conditional probability of the form P (S/K), it may be calculated as P (all relevant available evidence . S) ÷ P all relevant available evidence), or P (K . S) ÷ P (K), probability calculus. To further clarify the notion of epistemic probability, consider the epistemic probability of a statement with a determined truth value. First consider a statement that we know to be true. For example, 'Boston is the capital of Massachusetts'. Let us call this statement 'p'. Using p as a propositional constant, according to our definitions, the epistemic probability of p is a conditional probability of the form P (p/K). Clearly, among this relevant available evidence K is the fact that Boston is the capital of Massachusetts. This conditional probability, then, can be seen to have the form P (p . p . q . r . . .) where 'p . q . r' represents other relevant available facts. According to our calculations, P (p . q . r . p) ÷ P (p . q . r) = 1 since the numerator and the denominator of this fraction are identical. (For logical purposes, recall that p . p is logically equivalent to p.) Statements known to be true, therefore, have an epistemic probability of 1, since given the calculation procedure and the definition of epistemic probability, the resulting fractions have identical numerators and denominators.

Secondly, consider a statement that we know to be false. For example, 'New York is the capital of Massachusetts'. Using 'U' as a propositional constant, let us call this statement U. According to our definition, the epistemic probability of U is a conditional probability of the form P (U/K). Clearly, among this relevant available evidence K is the fact that it is not the case that New York is the capital of Massachusetts. This conditional probability, then, can be seen to have the form P (U . ∿ U . p . q . r . . .) where 'p . q . r . . .' represents other relevant facts. According to our calculation, P ($\sim$ U . p . q . r . . . U) $\div$ P (U . p . q . r . . .) = 0, since the probability of the numerator is 0 because the probability of a contradiction = 0. Statements known to be false, therefore, have an epistemic probability of 0, since given the calculation procedure, and the definition of epistemic probability, the resulting fractions have numerators equal to zero.

We may now see how this notion of epistemic probability helps us to avoid the problem of the detachment of premises, and thereby to avoid the problem of inductive inconsistency and to assert that an inductive argument's conclusion is highly probable, with the restriction that this assertion is made given all relevant available evidence. We can assert that C is highly probable if and only if C is the conclusion of an inductively strong argument, and we know the premises are true or highly probable, and the selection of the premises takes into account all relevant available evidence. This can be stated in our notation as follows: if Ø :. C is an inductively strong argument where 'Ø' represents a conjunction of premises and 'C' represents a conclusion, and P (Ø) > P ($\sim$ Ø), and P (C/Ø . K) > P ($\sim$ C/Ø . K), then P (C) > P ($\sim$ C).

Models

1. Do a "before and after" evaluation of the epistemic probability of some of VonDäniken's statements before the research was done, and after the research was done to show the students that as our body of knowledge increases, there is an effect on the epistemic probability of statements like those made by VonDäniken, or cite some claims, such as the mystical numerical properties of the pyramids, determine the epistemic probability, then provide the research to show that they are false, and redetermine the epistemic probability.

2. Determine the epistemic probability of some mysterious force at work in the Bermuda Triangle given the student's present knowledge of the Bermuda Triangle. Begin a consideration of Berlitz' book and point out that, like VonDäniken's, arguments must often be put into inductively strong form on the author's behalf.

3. From arguments previously considered, calculate the epistemic probabilities of premises known to be false, and premises known to be true.

4. Discuss intuition, and what an intuitive understanding is. Consult Quine and Ullian, The Web of Belief, Chapter VI.

Exercises

1. Have the students construct examples in which the epistemic probability of a statement is increased by learning facts that support the statement.

2. Have the students construct examples (VonDäniken) in which the epistemic probability of a statement is decreased by learning facts that do not support the statement.

3. Have the students evaluate epistemic probabilities of statements in Berlitz such as 'there are space-time warps' and 'UFO's are visitors from outerspace'.

Subsection 4 - The Role of Inductive Arguments: To Establish a Degree of Probability for a Conclusion

One might suppose, given 1.3 and 2.1, that one might simply conduct certain tests and make certain observations to determine the truth value of their conclusions. For example, we might just go down Jones' basement and conduct some agreed upon test procedure sufficient to determine whether 'Jones basement is wet' is true or false. We might send up a Viking satellite to conduct conclusive tests on Mars to determine whether 'there is intelligent life on Mars' is true or false. In fact, given recent technological developments, this is now technologically possible and having sent such a satellite we now know that 'there is intelligent life on Mars' is false. Similarly, it is obviously technologically possible to test Jones' basement to determine whether it is wet or not. We may then assign a truth value to a statement 'Jones basement is wet', based on the results of this test.

However, the determination of the truth values of these statements is independent of the inductive arguments under consideration. When we know the truth value of a statement forming the conclusion in an inductive argument, the probability of the conclusion is 0 or 1, since the probability of the conclusion is based on all relevant available evidence. However, when we do not know the truth value of the conclusion, an inductive argument is only able to provide the probability of the conclusion given the premises and all relevant available evidence. To ask any more of it is to overextend its logical function. Therefore, inductive arguments never, in principle, absolutely establish the truth value of the conclusion. If this is to be done, it is not logically possible to do so with inductive arguments. It may instead be done by independent methods such as direct empirical tests, as in the case of the conclusions of 1.3 and 2.1.

The fact that inductive arguments never in principle absolutely establish the truth value of the conclusion gives us some intuitive insight into the use of inductive arguments. For example, inductive arguments like 1.3 and 2.1, are useful under conditions such that direct empirical tests to determine the truth value of a statement are not physically or technologically possible. We must, therefore, rely on statements as evidence to support the given statement.

Inductive arguments are also useful in supporting claims for non-recurring events that it is not physically possible to test directly. Consider, for example, the statement 'Lee Harvey Oswald did not shoot and kill JFK'. Clearly we cannot conduct a direct empirical test to determine the truth value of this statement. It is not physically possible to ask him, since he is dead. It is not physically possible to go back in time and observe Lee Harvey Oswald on November 22, 1963. All we have are statements by witnesses; statements about doctored photographs, and statements about a lack of physical evidence connecting Oswald with the murder. We may conduct indirect empirical tests to determine the physical possibility of his firing three shots in 5.6 seconds, test the weapon to determine the technological possibility of its firing quickly and accurately, do forensic pathology, study the Zapruder film, etc. This is only useful regarding this statement if we put it in the form of evidence which is inductively strong support for the conclusion 'Lee Harvey Oswald did not shoot and kill JFK'.

To do so, we must consider all relevant available evidence. We may then determine the probability of the conclusion. It is important to notice that since the conclusion is based on all relevant available evidence, we must allow for new discoveries; we must allow for the disclosure of new facts which might change the probability of the conclusion.

Indeed, this is characteristic of all inductive arguments. The probabilities assigned to their conclusions depend on relevant available evidence. As we add to the store of knowledge and change the probabilities of certain statements given new information, we may affect the probability of inductively reached conclusions. Consider the following argument as an example of such an inductive argument dependent on all relevant available evidence:

4.1

1. Lee Oswald was seen by witnesses on the first floor of the Texas school book depository seconds after the President was shot and killed.
2. The photograph of Oswald holding the alleged murder weapon was faked.
3. Oswald had no trace of nitrates on his cheeks or hands when arrested.
4. Oswald was one point away from being released from the Marine Corps because of poor marksmanship.
5. The Mannlicher Carcano Rife, allegedly used by Oswald, is dangerous to the marksman and inaccurate.

:. 6. Oswald did not shoot and kill JFK.

Inductive arguments are also useful in supporting claims that it is not yet technologically possible to test directly. Consider, for example, the statement 'successful human brain transplants cure Parkinson's disease'. Clearly we cannot as yet conduct a direct empirical test to determine the truth value of the statement. However, we may assemble evidence and put it in the form of inductively strong arguments to support the conclusion 'successful human brain transplants cure Parkinson's disease'. We may then calculate the probability of the conclusion, given this and all relevant available evidence.

However, generally, and most importantly, inductive arguments are useful in supporting statements for which conclusive evidence is not yet or never will be available. These arguments are based on all relevant available evidence, given the impossibility of obtaining more evidence. Consider, for example, the statement 'the three TBM Avengers in flight 19 crashed into the Atlantic Ocean, and sank'.

Clearly, in investigating the crash we can find no direct proof that this statement is true. No wreckage was ever found. However, we can gather information about their flight path, the experience of the pilots, the weather conditions, the range of the planes, their fuel capacity, the time they left and the time a search for them began. This information is useful regarding this statement if we put it in the form of evidence for the conclusion 'the TMB Avengers in flight 19 crashed into the Atlantic Ocean and sank'. We may then determine the inductive strength of the argument and calculate the probability of the conclusion.

Such an argument might look like the following:

4.2

1. Eight of the nine crewmen were student trainees, only one pilot was an instructor.
2. From radio communications, the instructor appeared disoriented, and had no watch or clock.
3. The instructor was newly transferred and unfamiliar with the area.
4. When lost, the instructor failed to switch his radio to the emergency frequency and contact was lost.
5. Flight 19 was the last flight of the day, and the weather turned bad and it was dark.
6. Military discipline kept the flight together even though several students knew they were off course flying north over the Atlantic.
7. The planes flew north long enough to run out of fuel.
8. There was a long delay in sending out rescue craft.
9. TBM avengers sink in 90 seconds.
10. Storms at sea quickly dissipate wreckage and oil slicks.

∴ 11. The three TBM avengers crashed into the Atlantic Ocean and sank.

While inductive arguments do not allow us to assign a specific truth value to their conclusions, they do allow us to calculate the probability of the conclusion. We must now consider how one might begin to perform such calculations.

Models

1. Consider several of the "mysterious disappearances" discussed by Berlitz. Use the information provided in Kusche's book to construct strong inductive arguments to explain these disappearances.

2. Construct several inductive arguments from the views suggested by Berlitz to explain these "mysterious events" in the Bermuda Triangle. Show that they are inductively weak. Consider especially his claims about space-time warps, UFO's and the lost civilization of Atlantis.

Exercises

1. Have the students intuitively consider the inductive probability of the inductively strong arguments they presented on VonDäniken's behalf, which were discovered by research to have false premises.

2. Have the students construct inductively strong arguments on behalf of Berlitz. Have them show that they are inductively strong.

Subsection 5 - Statement Probabilities and Evaluating Inductive Arguments

We have seen that in order to get an inductive logic off the ground, we need some way to assign probabilities to the premises. Unfortunately, this must remain on an intuitive level. We shall assume that we can intuitively recognize what we have called evidence, thereby intuitively recognizing inductive strength by applying the above definition of a strong inductive argument in terms of evidence. However, we shall first consider this problem of assigning statement probabilities.

There is no general agreement among authorities about how to assign these statement probabilities. For our purposes here, we may define the statement probability of statement S as the epistemic probability of S. Thus, if a statement S is known to be true, its epistemic probability, as we have seen, equals 1; therefore, its statement probability equals 1. If a statement S is known to be false, its epistemic probability, as we have seen, equals 0; therefore, its statement probability equals 0. Unfortunately for statements that we do not know to be true or know to be false, the problem we experienced earlier with the calculation for inductive strength reappears. Therefore, here, too, we must rely on intuitions.

Consider a statement, S, that we do not know to be true and that we do not know to be false. The epistemic, and therefore, the statement probability of S, P (S/K), is calculated P (S . K) ÷ P (K). The problem is to assign a numerical value to the numerator and to the denominator. We can check to see if S and this relevant available evidence are independent. However, intuitively, we must check to see if it is more likely that S, given all relevant available evidence, is more probably true than ∿ S given all relevant available evidence. Consider, for example, the statement 'Lee Harvey Oswald, acting alone, shot and killed JFK'. Intuitively, P (S/K) > P (∿ S/K). We might work out a system to assign numerical values to the numerator and the denominator resulting in a value of say 1/9 or 1/19 or 1/100 for P (S/K). However, for our purposes here, it is sufficient to stick with our intuitively arrived at comparison. When P (S/K) > P(∿ S/K), it is obvious that P (S/K) is low. This may intuitively be determined by considering how much money you would be willing to bet that it is false or that it is true.

We now have an intuitive method for evaluating inductive arguments. First, we must intuitively determine whether the premises of the argument are evidence for the conclusion, that is, determine the inductive strength of the argument by determing if P (C/∅) > P(∿ C/∅). Secondly, we must determine the truth value or the probability of the premises. Thirdly, we must determine the probability of the conclusion not only in relation to the premises but also in relation to all relevant available evidence to determine if the premises are relevantly selected.

Let us now consider a simple application of this material to an inductive argument. Consider 1.1. We must first determine if the premises of this argument are evidence for the conclusion, thereby determining if the argument is inductively strong, or is inductively weak. To do so, we must ask whether P(5/1 . 2 . 3 . 4) > P (∿ 5/1 . 2 . 3 . 4) or P (5/1 . 2 . 3 . 4) $\leq$ P (5/1 . 2 . 3 . 4). If P (5/1 . 2 . 3 . 4) > P ($\sim$ 5/1 . 2 . 3 . 4), then the premises of 1.1 provide evidence for 5, and 1.1 is inductively strong. If P (5/1 . 2 . 3 . 4) $\leq$ P ($\sim$ 5/1 . 2 . 3 . 4), then the premises of 1.1 do not provide evidence for the conclusion and 1.1 is inductively weak. On an intuitive level, we might proceed as follows. We are concerned with assuming that (1) through (4) are true, and then determining whether, given these premises, the conclusion is the best explanation for them. Consider (1). If true, this is evidence for Ray's guilt. Intuitively, P (5/1) > P ($\sim$ 5/1). Therefore, (1) is evidence for (5). Consider (2). If true, this might be considered to be evidence for (5). Intuitively, P (5/2) > P ($\sim$ 5/2). Therefore, (2) is evidence for (5).

Consider (3). If it is true that witnesses saw him at the scene, then this is evidence for (5). Intuitively, P (5/3) > P ($\sim$ 5/3). Therefore, (3) is evidence for (5). Consider (4). If it is true, then this too is evidence for (5). Intuitively, P (5/4) > P ($\sim$ 5/4). Therefore, (4) is evidence for (5).

Consider intuitively the results; (1) is evidence for (5), (2) is evidence for (5), (3) is evidence for (5), and (4) is evidence for (5). Given this, we can see that $P(5/1 . 2 . 3 . 4) > P(\sim 5/1 . 2 . 3 . 4)$. Therefore, this shows by our definition of inductive strength, that 1.1 is a strong inductive argument.

The next step in evaluating an inductive argument is to consider the statement probabilities of the premises (1), (2), (3), (4), and all relevant available evidence. Since the premises are true, their probabilities are each 1. Note, however, that saying that they are true does not, as with valid deductive arguments, allow us to conclude that the conclusion is true. We must now construct an intuitive determination of the probability of the conclusion (5) of 1.1. To do so, we must consider whether $P(5/1 . 2 . 3 . 4 . K) > P(\sim 5/1 . 2 . 3 . 4 . K)$. If so, then $P(5) > P(\sim 5)$. If $P(5/1 . 2 . 3 . 4 . K)$ $P(\sim 5/1 . 2 . 3 . 4 . K)$, $P(5) \leq P(\sim 5)$, and this shows that the argument even though it may be inductively strong, fails to support the conclusion.

We must be satisfied to show why $P(5/1 . 2 . 3 . 4 . K) \leq P(\sim 5/1 . 2 . 3 . 4 . K)$ on an intuitive level. Consider (1). Even if true, when we appeal to all relevant available evidence, we learn that Ray was coerced into confessing. Consider (2). Even if true, when we appeal to all relevant available evidence, we learn that it is more probable than not that the FBI is covering up their own involvement. Consider (3). Even if true, when we appeal to all relevant available evidence, we learn that it is more probable than not that he had other reasons for being there. Consider (4). Even if true, when we appeal to all relevant available evidence, we learn that it is more probable than not that the trial was unfair and that Ray was found guilty just to satisfy public pressure for swift "justice." Therefore, we can intuitively see that the premises of 1.1 are not relevantly selected, and that $P\ (5/1\ .\ 2\ .\ 3\ .\ 4\ .\ K) \leq P\ (\sim 5/1\ .\ 2\ .\ 3\ .\ 4\ .\ K)$. Therefore, $P\ (5) \leq P\ (\sim 5)$, and the argument does not support the conclusion. Therefore, 1.1 is not a good inductive argument.

Consider an argument that we said earlier is an inductively strong argument. Consider 1.3. Let us use the numbers of the premises as propositional constants to determine if the premises are evidence for the conclusion, thereby determining the inductive strength of the argument. Again, if $P\ (5/1\ .\ 2\ .\ 3\ .\ 4) > P\ (\sim 5/1\ .\ 2\ .\ 3\ .\ 4)$, then 1.3 is an inductively weak argument. On an intuitive level, we might proceed as follows. Remember, we are concerned with assuming that (1) through (4) are true. Consider (1). If true, this alone is not evidence for (5). However, considering (2), (3) and (4) with (1), we can intuitively see that the conjunction of these premises is evidence for the conclusion. Given this, $P(5/1 \cdot 2 \cdot 3 \cdot 4) > P(\sim 5/1 \cdot 2 \cdot 3 \cdot 4)$. Therefore, this shows that the premises of 1.3 are evidence for the conclusion and that 1.3 is a strong inductive argument.

We must now consider the statement probabilities of the premises (1), (2), (3) and (4) and all relevant available evidence. Since the premises are, in fact, true, their statement probabilities are each 1. Consider the intuitive calculation of the probability of 1.3's conclusion. If $P(5/1 \cdot 2 \cdot 3 \cdot 4 \cdot K) > P(\sim 5/1 \cdot 2 \cdot 3 \cdot 4 \cdot K)$, then $P(5) > P(\sim 5)$. Again, we must be satisfied to show why $P(5/1 \cdot 2 \cdot 3 \cdot 4 \cdot K) > P(\sim 5/1 \cdot 2 \cdot 3 \cdot 4 \cdot K)$ on an intuitive level. Clearly (1), (2), (3) and (4), along with all relevant available evidence, is evidence for (5). The premises are not irrelevantly selected. Therefore, $P(5) > P(\sim 5)$, and the argument does support the conclusion. 1.3 is, therefore, a good inductive argument.

Let us consider an argument that we said was inductively strong, yet also has a conclusion that is more probably false than true, namely 2.1. Again, we shall use the numbers of the premises as propositional constants to stand for the respective statements and then determine whether the premises are evidence for the conclusion, thereby calculating the inductive strength of the argument.

If $P (9/1 . 2 . 3 . 4 . 5 . 6 . 7 . 8) > P (\sim 9/1 . 2 . 3 . 4 . 5 . 6 . 7 . 8)$, then 2.1 is an inductively strong argument. Again, assuming that the premises are true, (1) alone is not evidence for (9). Intuitively $P (9/1) \leq P (\sim 9/1)$. However, considering that (2) through (8) state that all other planets in our solar system have intelligent life, we can intuitively see that the conjunction of these premises is evidence for the conclusion, (9). Intuitively, given this, we can see that $P (9/1 . 2 . 3 . 4 . 5 . 6 . 7 . 8) > P (\sim 9/1 . 2 . 3 . 4 . 5 . 6 . 7 . 8)$. Therefore, this intuitive calculation shows that 2.1 is a strong inductive argument. It is useful to see why this argument does not have a highly probable conclusion.

To determine the probability of 9 of 2.1, we must first consider the statement probabilities of premises (1) through (8) and all relevant available evidence. Only (3), 'there is intelligent life on Earth', is, in fact, true. Scientists have concluded that there is no life on Mercury, and while they do not know that the rest of the premises are false, they have an extremely minute probability, given all the relevant available evidence about physical conditions necessary to support intelligent life and the physical conditions on these planets. Thus, P (1) $\leq$ P ($\sim$ 1), P (2) $\leq$ P ($\sim$ 2), P (3) = 1, P (4) $\leq$ P ($\sim$ 4), P (5) $\leq$ P ($\sim$ 5), P (6) $\leq$ P ($\sim$ 6), P (7) $\leq$ P ($\sim$ 7), and P (8) $\leq$ P ($\sim$ 8). If P (9/1 . 2 . 3 . 4 . 5 . 6 . 7 . 8 . K) $\leq$ P (9/1 . 2 . 3 . 4 . 5 . 6 . 7 . 8 . K), then P (9) $\leq$ P ($\sim$ 9). Again, we must be satisfied to show that P (9/1 . 2 . 3 . 4 . 5 . 6 . 7 . 8 . K) $\leq$ P ($\sim$ 9/1 . 2 . 3 . 4 . 5 . 6 . 7 . 8 . K) on an intuitive level. Since the probability of each of the premises except (3) is less than or equal to the probability of its denial, the probability of 9 given their conjunction is less than or equal to the probability of its denial when we consider all relevant available evidence. Therefore, P (9) $\leq$ P ($\sim$ 9) and the argument, even though it is inductively strong, does not support the conclusion.

Finally, let us consider A.2, the argument that we said in the introduction was an example of an inductive argument. Again, referring to A.2, we shall use the numbers of the premises and the conclusion as propositional constants and begin to determine whether the premises are evidence for the conclusion, thereby determining the inductive strength of A.2. If P (5/1 . 2 . 3 . 4) $\leq$ P($\sim$ 5/1 . 2 . 3 . 4), then A.2 is an inductively weak argument. Assuming that the premises are true, (1), even if true, taken alone or in conjunction with the other premises, that 8 x 10 Eastman view cameras take accurate undistorted pictures is not evidence for (5); intuitively P (5/1) $\leq$ P ($\sim$ 5/1). Even if true, (2) is also easily and clearly seen not to be evidence for (5), since the objects were in the camera's range and d is not great enough to show any curvature of the earth. Intuitively, P (5/2) $\leq$ P ($\sim$ 5/2). Even if true, (3) is also not evidence for (5), since the distance covered by the entire surface of Lake Winnebago is not great enough to show any curve in the earth's surface. Intuitively, P (5/3) $\leq$ P ($\sim$ 5/3). Even if true, (4) is not evidence for (5) since this does not show anything about the curvature of the Earth's surface; such cameras at such distances do not have a long enough focal length to show any curve on the Earth's surface. Intuitively, P (5/4) $\leq$ P ($\sim$ 5/4). Therefore, none of the premises are evidence for the conclusion. Given this, P (5/1 . 2 . 3 . 4) $\leq$ P ($\sim$ 5/1 . 2 . 3 . 4). Therefore, this shows that A.2 is a weak inductive argument. We need to go no further to judge that A.2 is not a good argument, since the premises are not evidence for the conclusion, A.2 does not support the conclusion that the Earth is not a sphere, but is flat.

We, therefore, have a clear intuitive basis for evaluating various inductive arguments. First, we determine whether the premises of the argument are evidence for the conclusion, thereby determining the inductive strength of the argument. If $P(C/\emptyset) > P(\sim C/\emptyset)$, then $\emptyset$ is evidence for C, and $\emptyset \therefore C$ is a strong inductive argument. If $P(C/\emptyset) \leqq P(\sim C/\emptyset)$, then $\emptyset$ is not evidence for C, and $\emptyset \therefore C$ is a weak inductive argument. If the argument is weak, then we are justified in rejecting the argument as support for the conclusion. If the argument is strong, then we must determine the truth value or the probability of the premises by determining if $P(\emptyset) > P(\sim \emptyset)$. We may then determine the probability of the conclusion. If $P(C/\emptyset \cdot K) > P(\sim C/\emptyset \cdot K)$, then $P(C) > P(\sim C)$. If $P(C/\emptyset \cdot K) \leqq P(\sim C/\emptyset \cdot K)$, then $P(C) \leqq P(\sim C)$, and the argument fails to support the conclusion.

Models

1. Consider the arguments that have been presented on behalf of VonDäniken and clearly evaluate them. Point out cases of inductively strong arguments with conclusions that have low probability. Note the problems of detachment and inductive inconsistency.

2. Consider student arguments and evaluate them, using this intuitive procedure. Carefully explain and make as explicit as possible the considerations that are involved in forming these intuitive views.

Exercises

1. Have the students write an evaluation of 4.1 and 4.2.

2. Have the students evaluate the arguments that they presented on behalf of Berlitz.

3. Have the students use an inductively strong argument to organize an essay designed to show that there is nothing mysterious about the Bermuda Triangle. Use a class discussion to evaluate these arguments, using these procedures; inductively strong? "High" or "low" probability of the conclusion?

Subsection 6 - A Brief Glance at the Problem of Induction

The problem of induction was pointed out, in its classical form, by the 18th century philosopher, David Hume. We can see that one way of looking at induction is to see inductive arguments as shaping our expectations of the unknown on the basis of what is known. For example, the anticipation of the future based on our knowledge of the past. The problem of induction is simply: why this method of relating premises and conclusions rather than some other method? The problem, then, takes the form of a request for the justification of this method of inductive argument.

Intuitively, we could rationally justify induction if we could prove that it reliably predicts the future, based on our knowledge of the past. Certainly we could not require that true premises yield true conclusions all the time in inductively strong arguments with a high inductive probability. This would be to require that inductive arguments guarantee true conclusions, which we saw only valid, sound deductive arguments can do. However, intuitively, we do want an inductive logic that gets true conclusions most of the time, given that this logic determines that the argument in question is inductively strong and that the conclusion has high probability. We might, therefore, justify induction by showing that such inductive arguments yield true conclusions from true premises most of the time.

However, Hume asks by what sort of reasoning could we establish that inductively strong arguments with high inductive probability yield true conclusions from true premises most of the time? The answer, of course, is either by deductively valid reasoning, or by inductively strong reasoning. It is claimed that Hume then shows that neither will successfully reach the desired result.

Suppose, argues Hume, that we attempt to use a deductively valid argument to justify induction. Since we want the argument to be sound, we can only use as premises things that we know. However, we do not know what the future will be like. If we did, there would be no need for an inductive logic upon which to base our predictions. We only know things about the past and present. If the argument is deductively valid, then the conclusion can make no factual claim about the future. (After all, "most of the time" does not mean most of the time in the past and present, it means most of the time in the past, present and future.) Since the conclusion cannot tell us how successful inductive arguments will be in the future, it cannot prove that inductively strong arguments with a high inductive probability give us true conclusions "most of the time." Therefore, argues Hume, a deductively valid argument cannot be used to rationally justify induction.

Suppose, Hume is said to argue, that we attempt to use an inductively strong argument to justify induction. But how do we determine that this argument is inductively strong? The answer, of course, is that we test it according to the standards of inductive strength defined in inductive logic. The problem here, of course, is obvious. If we attempt to justify induction in this way, we must assume that induction is reliable in order to prove that it is reliable. This, as we shall see later, is an instance of the fallacy known as begging the question.

Therefore, Hume has shown that there is a problem in attempting to justify induction by showing that providing both deductive and inductive arguments fails to justify it. These are clearly the only alternatives.

Many other proposals for justifying induction, either by deductive or inductive arguments, can be shown to suffer the same consequences. One such attempt worth noting here is based on the claim that the future resembles the past because it is true that nature is uniform. However, as Bertrand Russell pointed out, nature is not uniform in all respects:

> "The chicken on slaughter day might reason that whenever humans came, it had been fed, so when humans come today it would also be fed. The chicken thought the future would resemble the past, but he was dead wrong."

Therefore, clearly the future does not resemble the past in all respects. Therefore, this principle will not do to justify induction.

In our discussion of inductive logic, we have avoided this problem by keeping on an intuitive level. The problem arises, however, in that there appears as yet to be no clearly acceptable solution to the problem of assigning actual values to the probabilities of statements with unknown truth values. One might raise the problem, given some assignment of numerical value, by asking us to justify this numerical value and not some other.

Many philosophers of science have attempted to solve or dissolve this problem raised by Hume. For example, this has been attempted by some of those philosophers offering an account of 'probability'. (The problem of induction remains one of the important philosophical problems demanding solution.) However, for our purposes here, it is clear that inductive logic, justified or not, is here to stay, and that it is a useful and important argumentative tool.

Models

1. In advanced classes, explain the various interpretations of probability and especially how the subjectivist view avoids the problem of induction. Stress that this problem, while philosophically very important, does not prevent us from intuitively considering rules of inductive support.

2. Go through several other attempted solutions, and show the problems with them. This anticipates further uses for the critical skills considered in this course.

Subsection 7 - Evidence and Causes

Many non-deductive arguments do not involve the notion of probability at all. Some of these arguments involve the notion of 'cause', and are designed to establish, as a conclusion, the cause of a particular event. Some of these arguments involve the notion of 'symptom' and are designed to establish as conclusions, the symptoms for particular events. Such arguments involve particular kinds of evidential relations between premises and conclusions; casual relations and symptomatic relations. Although in the preceding subsections we were forced to rely on our intuitions in accounting for inductive evidential strength and inductive probability, we need not rely completely on our intuitions in accounting for casual evidential relations or symtomatic evidential relations between premises and conclusions. The word 'cause' as used in English captures many different concepts. In fact, ever since Hume published this <u>Inquiry Concerning Human Understanding</u>, the concept of what may be called empirical cause has been under a cloud of controversy. Similarly, the word 'symptom' as used in English captures many different concepts. For this reason, in considering such non-deductive arguments it is clearer and more useful to abandon talk of causes and symptoms and, instead, to adopt talk of what we shall call necessary conditions and sufficient conditions.

From our consideration of deductive logic, these notions should be familiar. To state, using 'O' and 'Δ' as propositional variables, $O \supset \Delta$, is to state that O is a sufficient condition for Δ. For example, to state that 'if I am shot in the head with a bazooka, then I shall die' is to state that being shot in the head with a bazooka is a sufficient condition for death. However, in this statement, being shot in the head with a bazooka is not a necessary condition for death, since one might die in other ways.

For example, one might die by being run over by a train, by being decapitated, or by succumbing to swine flu. Saying 'I shall die if I am shot in the head with a bazooka' is to say that death is a necessary condition of being shot in the head with a bazooka. This is not to say that death is a sufficient condition for being shot in the head with a bazooka, because one might die in other ways. Therefore, we can see that to say that O is a sufficient condition for Δ is also to say that Δ is a necessary condition of O. Recall that to state $O \equiv \Delta$ is to state that O is both necessary and sufficient for Δ. It follows, of course, from this that Δ is both necessary and sufficient for O. (As a review exercise, verify these logical equivalences using truth tables.)

When we use 'cause' in English, we sometimes refer to a sufficient condition, as when we say that being shot in the head with a bazooka caused his death. However, we sometimes refer to a necessary condition. For example, being exposed to the common cold virus is a necessary condition for catching a cold, but is not sufficient, since many who are exposed to the common cold virus do not catch a cold. Therefore, we refer to this necessary condition when we say that catching a cold is caused by being exposed to the common cold virus. On the other hand, when we refer to necessary and sufficient conditions, we sometimes do not refer to causes at all but rather refer to symptoms. For example, we might say that a burning candle is a sufficient condition for the presence of oxygen, but this is not to say that a burning candle causes the presence of oxygen; it is only to say that the burning candle is a symptom of its presence. Or we might say that a fever is a necessary condition for an infection, but this is not to say that a fever causes an infection; it is only to say that the fever is a symptom of the infection.

Many non-deductive arguments use both this notion of cause and this notion of symptom in a very confusing way. However, we shall avoid many complex terminological and conceptual difficulties by rejecting both the notions of cause and symptom in favor of the simple and rigorously defined notions of necessary conditions and sufficient conditions, since these notions capture all that we need to capture for such non-deductive arguments.

Models

1. Point out the role of logical equivalences in the discussion of necessary and sufficient conditions. Together with the class, apply DeMorgan's laws and list the logical equivalences of '$P \supset Q$' and of '$P \equiv Q$'.

2. Show how avoiding questions about causes and symptoms can lead to more clarity. Consider teleological causes, etc.

3. Discuss causes in terms of Berlitz' use of the notion in "seeking causes for the disappearances in the Bermuda Triangle."

Exercises

1. Have the student verify, using truth tables, the logical equivalences cited in Subsection 7.

2. Have the students list examples of several causes that are sufficient conditions for something and several causes that are necessary conditions for something.

Subsection 8 - Terms, Properties, and Presence Tables

We must now see how the notion of necessary conditions and sufficient conditions can be used to provide an account of the evidential relations in non-deductive arguments that do not involve a notion of probability. In PC we saw that complex statements were constructed from simple statements and the logical connectives. We may similarly construct complex terms from simple terms and the logical connectives. Thus, the term 'bald' may be conjoined with the term 'fat' to form the complex term 'bald and fat'. For clarity, let us say that terms name what we shall call properties. For example, 'bald' names the property we identify on men having no hair. Since terms are true of things or events, whether a complex term is true of a given thing or event depends upon whether what we shall call the corresponding complex property composed of constituent simple properties is present or absent in the given thing or event. Thus, for clarity, we may say that a term is true of a thing or event if and only if the corresponding property named by the term is, in fact, present in that thing or event; otherwise it is false of that thing or event.

We shall use a method to examine complex properties similar to the method of truth tables, and we shall call this method the method of presence tables. When the logical connectives are used to form complex terms naming complex properties, we can let 'F', 'G', 'H' stand for simple terms and 'P' stand for 'present' and 'A' stand for absent. Thus, the present table for '∿ F' is:

F	∿ F
P	A
A	P

and the presence table for F . G is:

F	G	F . G
P	P	P
P	A	A
A	P	A
A	A	A

and the presence table for 'F V G' is:

F	G	F V G
P	P	P
A	P	P
P	A	P
A	A	A

Note that these tables are the same as the truth tables for the logical connectives with 'present' substituted for 'true' and 'absent' substituted for 'false'. Thus, presence tables for properties may be constructed for all the logical connectives, just as truth tables for propositions were constructed for the logical connectives. (As an exercise, construct a presence table for 'F $\supset$ G', 'G $\supset$ G', and 'F $\equiv$ G'.)

We may now define necessary conditions and sufficient conditions in terms of properties:

(i) A property F is a sufficient condition for a property G iff whenever F is present, G is present.

(ii) A property H is a necessary condition for a property I iff whenever I is present, H is present.

Given these definitions and using the notions of logical equivalence, the logical connectives, and the presence tables, we may prove the following principle:

If whenever F is present, G is present, then whenever G is absent, F is absent.

(As an exercise, construct a presence table to prove this principle.)

Models

1. The discussion of terms, properties and presence tables can serve as a review and a specific application of the truth table method, involving the substitution of 'present' for 'true', and 'absent' for 'false'.

2. This is a good point to introduce the use-mention distinction (which the text, no doubt, confuses). Point out the use of single quotes (' ') to mention a term, and clarify the relation of terms to properties.

Exercises

1. Have the students write presense tables for all the logical connectives. Then present complex properties and have them construct presence tables for them. For example, $F \supset (G \cdot (H \vee I))$.

2. Have the students prove the principle stated at the end of the subsection, and have them deduce anything that follows from it, given our notions of necessary and sufficient conditions.

3. Prove that the following are correct:

   a) If $\sim G$ is a sufficient condition for $\sim F$, then F is a sufficient condition for G.

   b) If $\sim D$ is a necessary condition for $\sim G$, then G is a necessary condition for D, etc.

Subsection 9 - Inductive Elimination: The Direct Method of Agreement

Given the presence table method for determining the presence or absence of complex properties based on the presence or absence of simple component properties, and given our discussion of necessary and sufficient conditions, we are now ready to consider the method for finding the necessary or the sufficient conditions of a given property. We shall call this method inductive elimination. The method is very simple and is based on testing alternative properties to determine if they are necessary or sufficient conditions for a given property. Inductive elimination allows us to evaluate arguments designed to show that certain properties are necessary or sufficient for certain other properties. It does so by allowing us to evaluate the selection of certain properties that are claimed to be the causes or to be the symptoms of certain other properties by providing a mechanical test for the proposed properties.

We shall call properties whose necessary or sufficient conditions are being sought the <u>conditioned property</u>. We shall call the properties suspected of being necessary or sufficient conditions for a given conditioned property <u>possible conditioning properties</u>. We may select the necessary or sufficient conditioning property for the conditioned property from among the possible conditioning properties by one of five test methods: 1) the direct method of agreement, 2) the inverse method of agreement, 3) the method of difference, 4) the double method of agreement, and 5) the joint method of agreement and difference. Furthermore, if the examined possible conditioning properties include the actual conditioning property (either necessary, sufficient, or necessary and sufficient conditioning property), then these test methods of inductive elimination lead to it with certainty. That is, successful applications of inductive elimination allow us to conclude that a statement of the form 'if the actual conditioning property is among the considered possible conditioning properties, then this it is'. It is important to recognize that everything we shall say about inductive elimination, and everything that we shall exclude concerning more complex properties, is based upon two simple elimination principles:

(i) A necessary condition for a conditioned property cannot be absent when the conditioned property is present.

(ii) A sufficient condition for a conditioned property cannot be present when the conditioned property is absent.

The Direct Method of Agreement

Suppose that we are asked to evaluate the statement 'a fever is a necessary condition for an infection'. Infection, here, is the conditioned property, H, and among the alternative conditioning properties we find fever, C. The direct method of agreement allows the discovery of necessary conditions for a given conditioned property by the elimination of possible necessary conditions by what we shall call "counter-examples." Given our definition of 'necessary condition', we know that possible necessary conditioning property C is eliminated as an actual necessary conditioning property for conditioned property H iff conditioned property H is present and C is absent. A counterexample, in this test, therefore, is a specific case that is an example of the presence of H and the absence of C. To find a counterexample to this statement 'a fever is a necessary condition for an infection', we must find a case in which an infection is present and a fever is absent. Finding such a case entitles us to conclude that 'a fever is a necessary condition for an infection' is false.

Suppose that the possible conditioning properties E, F, G, H and I are to be tested to determine which are necessary conditions for conditioned property J. By our definition, any such property that is absent when J is present cannot be a necessary condition for J. Clearly, experimental manipulations or other empirical observations are required to determine the presence or absence of these conditioning properties in occurrences where the conditioned property is present. Thus, the determination of a counterexample will depend on tests and corresponding observations. Consider the following presence table:

	Possible Conditioning Properties					Conditioned Properties
	E	F	G	H	I	J
test occurrence 1	A	P	P	P	A	P
test occurrence 2	A	P	A	P	P	P
test occurrence 3	A	A	P	P	A	P

Occurrence 1 shows us that E is not a necessary condition for J. Therefore, this occurrence counts as a counter-example to the statement 'E is a necessary condition for J'. Therefore, we know that this statement is false. Occurrence 1 also shows us that I is not a necessary condition for J. Occurrence 2 has the same results for G and again for E and occurrence 3 has the same results for F and again for E.

The only candidate left is H. However, this does not, as yet, show that H is a necessary condition for J. It is important to note that it only shows a conditional of the form 'If one of the possible conditioning properties E, F, G, H, I is a necessary condition for J, then H is that necessary condition'.

However, we might consider the claim that while E is not a necessary condition for J, $\sim$ E is. Remember that, according to the presence table for negation, $\sim$ E is present when E is absent. Therefore, we might consider adding such complex properties.

	Possible Conditioning Properties: Simple					Complex				
	E	F	G	H	I	$\sim$ E	$\sim$ F	$\sim$ G	$\sim$ H	$\sim$ I
test occurrence 1	A	P	P	P	A	P	A	A	A	P
test occurrence 2	A	P	A	P	P	P	A	P	A	A
test occurrence 3	A	A	P	P	A	P	P	A	A	P

	Conditioned Property J
test occurrence 1	P
test occurrence 2	P
test occurrence 3	P

Occurrence 1 shows that E, I, ∿ F, ∿ G and ∿ H are not necessary conditions for J. Occurrence 2 shows that E, G, ∿ F, ∿ H, and ∿ I are not necessary conditions for J. Occurrence 3 shows that E, F, I, ∿ G, and ∿ H are not necessary conditions for J. Therefore, all have been eliminated as necessary conditions except H and ∿ E. Therefore, if one or more of the possible conditioning properties, E, F, G, H, I, ∿ E, ∿ F, ∿ G, ∿ H, and ∿ I are necessary conditions for J, then H and ∿ E are those necessary conditions.

Since we can determine the presence or absence of a complex property like 'E V F' in a given occurrence by knowing the presence or absence of its simple component properties, we may assign values to complex properties simply by appeal to the presence tables for their logical connectives, and by appeal to the actual values of their simple component properties in a given occurrence. Any such property that is absent when J is present cannot be a necessary condition for J.

This method can be compared to a method by which Sherlock Holmes eliminates suspects in a murder case, one by one. Holmes does not know beforehand that he will be able to eliminate all but one suspect, since there may have been a conspiracy or since the list of suspects may not include the real murderer. Likewise, in this method we must realize that a conditioned property may have more than one necessary condition and that our list of possible conditioning properties may not include the necessary conditions.

Models

1. Explain why the conclusion resulting from applying these methods has the logical form of the conditional. Relate this discussion to a consideration of evidence gathering in the form of research, or empirical test.
2. Reemphasize the elimination principles and explain how simple their application is, given test procedures.
3. Suggest how one might use the direct method of agreement to test claims about necessary conditions for disappearances in the Bermuda Triangle.

Exercises

1. In the first example, which of the following complex properties are eliminated as necessary conditions for J by test occurrences 1, 2 and 3?

   a) $\sim F$

   b) $\sim G$

   c) $\sim H$

   d) $\sim I$

   e) $F \vee I$

   f) $G \vee H$

2. Consider Berlitz' suggestions about the causes of various disappearances in the Bermuda Triangle. Construct a series of tests to determine the necessary conditions for such disappearances. Consider the ships <u>Rosalie</u>, the <u>Mary Celeste</u>, and the <u>Cyclops</u>.

Subsection 10 - Inductive Elimination: The Inverse Method of Agreement

Suppose that we are asked to evaluate the statement 'being shot in the head with a bazooka is a sufficient condition for death'. Death here is the conditioned property H, and among the alternative conditioning properties we find being shot in the head with a bazooka, C. The inverse method of agreement allows the discovery of sufficient conditions for a given conditioned property by the elimination of possible sufficient conditions by counterexample. Given our definition of 'sufficient condition', we know that possible sufficient conditioning property C is eliminated as an actual sufficient conditioning property for conditioned property H iff C is present and conditioned property H is absent. A counterexample in this test, therefore, is a specific case that is an example of the presence of C and the absence of H. To find a counterexample to the statement 'being shot in the head with a bazooka is a sufficient condition for death', we must find a case in which someone is shot in the head with a bazooka and does not die. Finding such a case entitles us to conclude that 'being shot in the head with a bazooka is a sufficient condition for death' is false.

Suppose that the possible conditioning properties E, F, G, H and I are to be tested to determine which are sufficient conditions for conditioned property J. By our definition, any such property that is present when J is absent cannot be a sufficient condition for J. Again, the determination of counterexamples will depend on tests and corresponding observations. Consider the following presence table:

	Possible Conditioning Properties				Conditioned Property
	F	G	H	I	J
test occurrence 1	P	A	A	A	A
test occurrence 2	A	P	A	A	A
test occurrence 3	P	A	P	A	A

Occurrence 1 shows us that F is not a sufficient condition for J. Therefore, this occurrence counts as a counter-example to the statement 'F is a sufficient condition for J'. Therefore, we know that this statement is false. Occurrence 2 has the same result for G, and occurrence 3 has the same results for H and again for F.

The only candidate left is I. However, this does not, as yet, show that I _is_ a sufficient condition for J. It is important to note that it only shows a conditional of the form 'if one of the possible conditioning properties F, G, H and I is sufficient condition for J, then I is that sufficient condition'.

We may use the same method when dealing with complex properties; a complex property that is present when a conditioned property is absent cannot be a sufficient condition for that property.

This method also can be compared to a method by which Sherlock Holmes eliminates suspects in a murder case, one by one. Like Holmes in regard to his suspects, in this method, we must realize that a conditioned property may have more than one sufficient condition and that our list of possible conditioning properties may not yet include the sufficient conditions.

Models

1. Suggest how one might use the inverse method of agreement to test claims about sufficient conditions for disappearances in the Bermuda Triangle.
2. Begin a consideration of Arigo and point out the possible use of such test procedures to determine causes for phenomena cited by Fuller.

Exercises

1. Prove that the inverse method of agreement is logically equivalent to the direct method of agreement applied to negative properties.

2. Construct a series of test occurrences designed to determine the sufficient condition for a conditioned property J given complex properties $(F \vee \sim G)$, $(H \cdot G)$, and $(I \supset F)$ in addition to the properties listed in the example and their negations.

3. Propose tests that could be used to point out the sufficient conditions for Arigo's meaningless scroll "translated" by a typist into prescriptions. (Focus on the relation between the scroll and the typist.)

Subsection 11 - Inductive Elimination: The Method of Difference

Suppose that we find a man dead, with no evidence of physical violence, and are asked to evaluate the statement 'this man died of cancer'. It is clear that we seek a sufficient condition for death, but we are not seeking just any sufficient condition; we seek a sufficient condition for death among the properties present in this particular occurrence. This question limited to a particular context cannot arise for necessary conditions, since it follows from the definition of 'necessary condition' that whenever the conditioned property occurs, all necessary conditioning properties automatically occur. Therefore, we can see that the question "What are the necessary conditons for death?" and "What are the necessary conditions for this man's death?" have the same answer. However, such is not the case for sufficient conditions. When a given conditioned property such as death is present, some of its sufficient conditioning properties may be absent. Thus, the list of conditioning properties to be considered in this particular occurrence will be shorter than if we are considering a list of possible conditioning properties simply sufficient for death.

We might proceed as follows. Since we know that there is no evidence of physical violence, we may rule out as possible conditioning properties all properties having to do with physically violent death (bazookas, trains, knives, etc.). We may, therefore, consider poisons, disease, heart attack, etc., and rule them in or out on the basis of the other properties that are present. For example, being emaciated, or being muscular, etc. The actual method is the same as the inverse method of agreement. A property that is present when the conditioned property is absent cannot be a sufficient condition for the conditioned property.

Let us define such an actual occurrence as follows:

	Narrowed Down Possible Conditioning Properties				Conditioned Properties
	F	G	H	I	J
actual occurrence	P	A	P	P	P
test occurrence 1	P	A	A	A	A
test occurrence 2	A	A	A	P	A

Test occurrences 1 and 2 eliminate F and I as sufficient conditions for J by our principle, since F is present and J is absent in occurrence 1, and I is present and J is absent in occurrence 2. Only H is left from among the possible conditioning properties present in the actual occurrence. Therefore, we may conclude that if one of the possible conditioning properties F, G, H, or I, which were present in the actual occurrence is a sufficient condition for J, then H is that sufficient condition. Note that G <u>might</u> also be a sufficient condition for J, but it is not of interest to us for the method of difference because it was absent in the actual occurrence.

Again, we may use the same method when dealing with complex properties. Again, we are limited to the properties involved in the actual occurrence. Otherwise the method is the same as for the inverse method of agreement. For example:

Narrowed Down Possible Conditioning Properties

	Simple				Complex			
	F	G	H	I	$\sim$ F	$\sim$ G	$\sim$ H	$\sim$ I
actual occurrence	P	A	P	P	A	P	A	A
test occurrence 1	P	A	A	P	A	P	P	A
test occurrence 2	A	A	A	P	P	P	P	A

Conditioned Property

	J
actual occurrence	P
test occurrence 1	A
test occurrence 2	A

Clearly, given the actual occurrence, if both simple properties and their negations are allowed as possible conditioning properties, exactly half will be candidates for being the sufficient condition since exactly half will be present in any occurrences. Therefore, given the actual occurrence F, H, I, $\sim$ G, are candidates for being sufficient conditions for J. Test occurrence 1 eliminates I and G, and test occurrence 2 eliminates $\sim$ G. Therefore, if one of the possible conditioning properties present in the actual occurrence is a sufficient condition for J, then H is that sufficient condition.

Models

1. Explain that the method of difference is most likely to be applied to what we have referred to as non-recurring events, in which we seek the particular sufficient condition for the event in this case. Use an illustration from Fuller's book, such as Arigo's "eye surgery" with the rusty knive. It was painful when anyone but Arigo placed a knife under the eyelid. Formulate a set of possible conditioning properties and explain several test occurrences to discover the sufficient condition for this phenomenon.

2. Discuss the use of complex conditioning properties other than negative properties. Consider conjunctive, disjunctive and conditional properties. Give examples of such properties from Fuller's book on Arigo. Use the method of difference to discover from among a set of complex properties a complex property that is a sufficient condition for the property of 'appearing to have an operation.'

Exercises

1. Have the students apply the method of difference to the following situation:

Possible Conditioning Properties

	Simple				Complex			
	F	G	H	I	$\sim F$	$\sim G$	$\sim H$	$\sim I$
actual occurrences	P	A	A	P	A	P	P	A

Conditioned Property

	J
actual occurrences	P

a) Describe a test result that would eliminate all the candidates but one.

b) Describe a test result that would eliminate all the candidates.

c) What are the conclusions to be drawn, given the actual occurrences and the results you describe?

2. Have the students pick an occurrence described in Fuller's book and formulate a test procedure to find the sufficient condition for this particular occurrence.

Subsection 12 - Inductive Elimination: The Double Method of Agreement

Suppose that we are asked to evaluate a statement of the form 'F is a necessary and a sufficient condition for J'. We have already considered a method for finding necessary conditions, namely the direct method agreement, and two methods for finding sufficient conditions, namely the inverse method of agreement and the method of difference. We may combine the direct and inverse methods of agreement to form what we shall call the double method of agreement. This will allow us to apply our principles of elimination to determine necessary and sufficient conditions.

Consider the following example:

	Possible Conditioning Properties							
	Simple				Complex			
	F	G	H	I	$\sim$ F	$\sim$ G	$\sim$ H	$\sim$ I
test occurrence 1	P	A	P	A	A	P	A	P
test occurrence 2	A	P	P	P	P	A	A	A
test occurrence 3	A	P	A	P	P	A	P	A
test occurrence 4	P	A	A	A	A	P	P	P

	Conditioned Property
	J
test occurrence 1	P
test occurrence 2	P
test occurrence 3	A
test occurrence 4	A

First, applying the direct method of agreement, test occurrence 1 eliminates G, I, $\sim$ F, and $\sim$H, and test occurrence 2 eliminates F, $\sim$ G, $\sim$ H, and $\sim$ I as necessary conditions for J, since they are absent when J is present. Given test occurrences 1 and 2, by applying the direct method of agreement, we can conclude that if one of the possible conditioning properties is a necessary condition for J, then H is that necessary condition. Secondly, applying the inverse method of agreement, test occurrence 3 eliminates G, I, $\sim$ F, and $\sim$ H, and test occurrence 4 eliminates F, $\sim$ G, $\sim$ H, and $\sim$ I as sufficient conditions for J since they are present when J is absent. Given test occurrences 3 and 4, by applying the inverse method of agreement, we can conclude that if one of the possible conditioning properties is a sufficient condition for J, then H is that sufficient condition. We may then combine these test results obtained by the direct method of agreement and the inverse method of agreement and conclude that if one of the possible conditioning properties is both a necessary and a sufficient condition for J, then H is that property.

Models

1. Introduce the notion of an expectation influenced observation. (Rely on a magic trick to explain this concept.) Consider a simple rope trick; tie a knot in a rope while "holding" the ends in each hand, and ask students to record their observations, and produce a condition that is both necessary and sufficient to explain the trick, by using the double method of agreement. Point out that the difficulty will be selecting the possible conditioning properties.

2. Provide more examples from Fuller's book on Arigo to show how the double method of agreement can be used to find necessary and sufficient conditions.

Exercises

1. Have the students use the double method of agreement to provide a possible necessary and a sufficient condition for Arigo's supposed ability to stop the flow of blood with a sharp verbal command. Point out to them the difficulty and the importance of selecting possible

conditioning properties for this conditioned phenomonon. (Again, recall expectation influenced observation and tricks.)

2. Given the example in Subsection 13, what can we say about the complex properties $(F \vee \sim F)$, $(F > \sim G)$, $(\sim I \; . \sim F)$, given the presence table as described?

   a) Test occurrence 1?

   b) Test occurrence 2?

   c) Test occurrence 3?

   d) Test occurrence 4?

   e) What can we conclude about these properties in relation to J?

Subsection 13 - Inductive Elimination: The Joint Method of Agreement and Difference

Suppose that we are asked to evaluate a statement of the form 'F is a necessary and a sufficient condition for J', limited to a particular actual occurrence of possible conditioning properties. This, as we can see, combines the direct method of agreement and the method of difference.

Consider the following example:

Possible Conditioning Properties

	Simple				Complex			
	F	G	H	I	∿ F	∿ G	∿ H	∿ I
actual occurrence	P	A	P	A	A	P	A	P
test occurrence 1	P	A	A	A	A	P	P	P
test occurrence 2	A	P	P	P	P	A	A	A

Conditioned Properties

	J
actual occurrence	P
test occurrence 1	A
test occurrence 2	A

First, applying the method of difference to the actual occurrence provides us with the candidates for the sufficient condition for J: F, H, ∿ G, and ∿ I. Test occurrence 1, however, eliminates F, ∿ G, and ∿ I as sufficient conditions for J, since they are all present when J is absent. This leaves only H. Therefore, given the actual occurrence and test occurrence 1, if one of the possible conditioning properties present in the actual occurrence is a sufficient condition for J, then H is that sufficient condition. Secondly, applying the direct method of agreement again to the actual occurrence provides us with the candidates for the necessary condition for J; F, H, $\sim$ G, and $\sim$ I. Test occurrence 2, however, eliminates F, $\sim$ G, and $\sim$ I. Test occurrence 2, however, eliminates F, $\sim$ G, and $\sim$ I as necessary conditions for J since they are absent in an occurrence where J is present. This leaves only H. Therefore, given the actual occurrence and test occurrence 2, if one of the possible conditioning properties present in the actual occurrence is a necessary condition for J, then H is that necessary condition. We may then combine these test results obtained by the method of difference and the direct method of agreement and conclude that if one of the possible conditioning properties present in the actual occurrence is a sufficient condition for J and if one of the possible conditioning properties is a necessary condition for J, then the possible conditioning property H is both a necessary and sufficient condition for J.

Models

1. Fuller describes the investigation of Arigo as a full scale, complete scientific investigation. Suppose that this is a particular conditioned phenomena. First use the double method of agreement to arrive at a necessary and sufficient condition for such an investigation. Then use the joint method of agreement and difference (given the investigation of Arigo that Fuller presents) to determine the necessary and sufficient condition appealed to by Fuller for such an investigation. Point out that the problem of course,

is that the investigation of Arigo was not a full scale complete scientific investigation.

2. Present, with the class, a valid sound deductive argument about the above results.

Exercises

1. Suppose you observe the following:

Possible Conditioning Properties

	Simple				Complex			
	F	G	H	I	∿ F	∿ G	∿ H	∿ I
Test 1	P	P	A	A	A	A	P	P
Test 2	P	A	A	A	A	P	P	P
Test 3	A	P	P	P	P	A	A	A

Conditioned Property

	J
Test 1	P
Test 2	A
Test 3	P

a) Which could be a necessary condition for J? Why?

b) Which could be sufficient for J? Why?

c) Which could be both necessary and sufficient? Why?

2. Have the students write a short essay in which they:

a) State sufficient conditions for using inductive elimination.

b) State necessary conditions for using inductive elimination.

Subsection 14 - The Applications of Inductive Elimination

Inductive elimination is useful, as we have seen, when we are evaluating statements for which we can devise some sort of empirical test procedure. For example, suppose that we are asked to evaluate the statement 'Norbu Chen's psychic power is a sufficient condition for restoring health to his patients'. Clearly we shall use the inverse method of agreement. However, this method depends for its usefulness on the selection of possible conditioning properties likely to include the actual sufficient condition for restoring health to his patients. Furthermore, it assumes for the purpose of the test, that his patients are indeed healthy after this psychic treatment. This, unfortunately, is not mechanical decision procedure, like inductive elimination. It is based again on what we have referred to as inductive intuitions. In providing possible conditioning properties to test using inductive elimination we must use our inductive intuitions to distinguish relevant conditioning properties from irrelevant, yet still possible, conditioning properties.

For example, in determining sufficient conditions for the conditioned property, we might include as possible conditioning properties: already healthy, psychic power, placebo effect, earlier drugs, simultaneous medical treatment, spontaneous remission, psychosomatic illness, and certain properties formed by negation, or the other logical connectives, and these simple properties. We might exclude as irrelevant possible conditioning properties: dormancy of disease, since the case described assumes that his patients are indeed healthy after his psychic treatment. We may then observe test occurrences to note the presence or the absence of the possible conditioning properties and and the corresponding presence or absence of the conditioned property.

However, the method of inductive elimination also depends for its usefulness on the ability to gather such data and perform such tests in numerous test occurrences to eliminate one by one the possible conditioning properties. When it is not physically or technologically possible to gather such data or to perform such tests (as when Norbu will not, in fact, permit such tests or when there are no records to serve as data), we must again rely on constructing inductively strong arguments with a high inductive probability. Therefore, the application of inductive elimination depends upon the selection of possible conditioning properties and the ability to gather data and perform such tests.

Models

1. As a review, reemphasize the importance of the two basic principles which are the foundation of inductive elimination.

2. Go through the various accounts Fuller provides of Arigo's "operations," suggest test occurrences to provide sufficient, necessary, and necessary and sufficient conditions for the conditioned property of 'being faked'.

3. Point out the intuitive procedure for choosing possible conditioning properties for testing. This is a good place to talk about "scientific method" and to show that all experiments are designed carefully to rule out certain possible conditioning properties. They are ruled out at this intuitive level. Give some examples from the natural sciences.

Exercises

Given the inability to determine if many of Arigo's patients were sick to begin with, and given the various test occurrences, construct an inductively strong argument to show that Fuller does not provide sufficient evidence to support his view that Arigo has extraordinary healing powers. (Note how inductive elimination can provide premises for such an argument.)

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Section Three: Clarifying Arguments

Subsection 1 - Clarifying The Logical Form of Arguments: The Principles of Charity

We have now seen how we can evaluate both inductive and deductive arguments. We have also seen that when such arguments are used in an attempt to support certain conclusions, they are often not presented as clearly as they might be. For example, both A.1 and A.2 were formulated on Voliva's behalf, given less clear statements of each argument. We have also considered various arguments unclearly presented by various authors and found that in order to evaluate these arguments, we must first attempt to present them in deductively valid or inductively strong logical form. If this is not possible, then we may argue that they are invalid, or inductively weak. Therefore, an argument composed of a statement or set of statements as premises and a statement of a conclusion said to follow from them deductively or inductively may be unclear because the logical form of the statement or set of statements is unclear.

We may use PC, LPC or inductive logic in the attempt to capture the logical form of such unclear arguments. First we must decide if the argument can be most plausibly and clearly formulated as a deductive or as an inductive argument. For example, reading over the paragraph from which A.1 was formulated, we can see the logical relationships of statements in a conditional form and the negation of the consequent in the premises leading to the negation of the antecedent as the conclusion. We immediately recognize this as a deductively valid logical relation. However, reading over the paragraph from which A.2 was formulated, we can see no such logical relationship between the premises and the conclusion. Rather, the premises are intended as evidence to support the conclusion. Therefore, we immediately recognize this as an attempt to provide an inductive relation between the premises and the conclusion.

Sometimes authors presenting such arguments present obviously invalid deductive arguments. In clarifying such arguments, it is important to capture this invalid logical form if and only if the conclusion reached by the argument depends for its support completely on this invalid logical move. We may, therefore, clarify the argument by capturing this logical form, and evaluate the argument by showing that the argument fails to support the conclusion because the conclusion depends for its support completely on an invalid logical move. For example, an author may present an argument of the form:

$$\begin{array}{rl} 1. & \Delta \supset \circ \\ \underline{2.} & \circ \\ \therefore\ 3. & \Delta \end{array}$$

We may then just capture its logical form and point out that deductive arguments of this form do not support their conclusions, even if the premises are true.

Sometimes authors like Voliva, in presenting such arguments, present what are invalid deductive arguments when rigorously interpreted. However, in clarifying such arguments, it is important to capture a valid logical form if the conclusion reached by the argument does not at all depend for its support on this invalid logical move. We may, therefore, clarify the argument by presenting it in a valid deductive logical form and evaluate the argument by showing that the argument is or is not sound. In clarifying Voliva's first argument, we put it into deductively valid logical form in terms of A.1 and then showed that while valid, A.1 failed to support its conclusion because it was unsound.

Sometimes authors presenting such arguments present obviously inductively weak arguments. In clarifying such arguments, it is important to capture this inductive weakness if and only if the conclusion reached by the argument is supportable by no other relevant, known evidence. We may, therefore, clarify the argument by capturing this inductive weakness and evaluate the argument by showing that since the argument is weak, the probability of the conclusion is low, and that, therefore, the argument fails to support the conclusion. For example, in clarifying Voliva's second argument, we put it into an inductive logical form in terms of A.2 and then showed that A.2 was inductively weak and that, therefore, A.2 failed to support its conclusion.

Sometimes authors presenting such arguments present what are inductively weak arguments that may be strengthened on the basis of other relevant known evidence. In clarifying such arguments it is important to capture an inductively strong argument if the conclusion reached by the argument is supported by other relevant known evidence. We may, therefore, clarify the argument by providing the additional premises required to present an inductively strong argument, and evaluate the argument by calculating the probability of the conclusion.

In supplying such missing premises and putting arguments into deductively valid logical form, or inductively strong logical form, given the necessary and sufficient conditions for doing so stated above, or deciding that arguments depend upon invalid deductive form or inductively weak logical form, we are applying what we call the principle of charity. The principle of charity states that the clearest and most plausible construal possible of a given argument that is consistent with its author's expressed or implied views must be provided before a conceptually significant critical evaluation of the argument can take place. This prnicíple was applied to all four cases considered above. To preserve conceptually significant criticism, we shall require the principle of charity be applied when evaluating arguments presented by various authors.

However, we often must apply the principle of charity to more than simply the logical form of arguments in order to clarify such arguments before evaluating them. This principle may also be applied to unclear expressions as well.

Models

1. Present several examples of arguments with unclear logical form. Consider arguments presented by VonDäniken, Berlitz, Fuller, or Blum. While repairing their logical form, explain the principle of charity by intuitively considering the notion of conceptually significant criticism. Point out that conceptually significant criticism implies that the obviously repairable defects of a given argument - in this case

repairable logical form - are not the basis for establishing that the argument is no good. We must first repair the argument as much as possible before evaluation is to be conceptually significant.

2. Present several examples of arguments that depend on defects in their logical form to support the conclusion. Point out that these arguments may not be repaired and that we are entitled to conclude that these arguments are not conceptually significant arguments.

Exercises

1. Have the students distinguish arguments which depend on some error in logical form to support the conclusion from arguments that have repairable logical forms.

2. Have the students repair these repairable arguments by applying the principle of charity.

Subsection 2 - Clarifying the Intensions and Extensions of Expressions

To see when and how we might apply the principle of charity to an author's use of a predicate or a term or a statement, we must first understand how a predicate, term, or statement can be used unclearly, and how their unclear uses are to be evaluated. We may, therefore, by appeal to the principle of charity, reconstrue arguments using such unclear predicates, terms or statements, or show that such arguments fail to support their conclusions because of such unclear predicates, terms or statements.

We have seen that predicate terms are true of certain things. We have also seen that the set of things that a predicate is true of is called the extension of the predicate term. Thus, for example, the extension of 'red' is all red things. Predicate terms also have what are called intensions. The intension of a predicate term is its meaning, which is the property or concept it expresses. For example, the intension of the predicate 'red' is the property or concept redness.

Individual terms such as 'dog' also have extensions and intensions. The extension of an individual term is the set of things it refers to. For example, the extension of 'dog' is the thing that the individual term refers to; namely all dogs. The intension of an individual term is its meaning, which is the concept it expresses. For example, the intension of 'dog' is the concept of dog.

Statements also have extensions and intensions. The extension of a statement is the truth value of the statement. For example, the extension of '$(P \,.\, Q) \supset P$' is 'true'. The intension of a statement also is its meaning, which in turn is what we shall call the proposition it expresses. For example, consider the statement 'Miss Jones and Miss Smith walked to Woolco to buy a box of candy and an umbrella', and the statement 'Miss Smith and Miss Jones walked to Woolco to buy an umbrella and a box of candy'. Both statements have the same intension.

Therefore, we say that the two statements are cointentional, that is, they express the same proposition.

This consideration of the extension and the intension of predicates, individual terms, and statements leads to the following definitions:

D.(1) A predicate term, indivdual term, or statement is said to be <u>coextensional</u> with a given predicate term, individual term or statement iff both predicate terms, individual terms, or statements have the same extension.

D.(2) A predicate term, individual term, or statement is said to be <u>cointensional</u> with a given predicate term, individual term, or statement iff both predicate terms, individual terms, or statements have the same intension.

These two definitions, in turn, lead to two principles which are important for the evaluation of certain arguments:

P.(1) The substitution of coextensional predicates, individual terms, or statements for corresponding predicates, individual terms, or statements preserves extension.

P.(2) The substitution of cointensional predicates, individual terms, or statements for corresponding predicates, individual terms, or statements preserves intension.

Consider P.(1). Suppose we know that 'the morning star' and 'the evening star' are both expressions that refer to the planet Venus; that is, that they are coextensional.

Therefore, P.(1) allows us to substitute 'the morning star' for 'the evening star' in the following statement and preserve extension; that is, be assured of making the statement about the same object, namely Venus: 'the evening star is further from Earth than Mars'.

Consider P.(2). Suppose we know that 'brother' and 'male sibling' both have the same meaning; that is, that they are cointensional. Therefore, P. (2) allows us to substitute 'brother' for 'male sibling' in the following statement and preserve intension; that is, be assured of making a statement with the same meaning: 'Joe is Henry's male sibling'. These principles are, therefore, useful in arguments for assuring the preservation of extension or intension.

However, often authors of arguments confuse these two principles and the result may be seen as an appeal to a false principle: the substitution of coextensional expressions preserves intension. This can easily be seen to be false. Suppose we have a statement in the logical form of a tautology, 'the morning star is identical to the morning star'. This statement is necessarily true since everything is self-identical. The assignment of 'true' to this statement is based on the intension of 'the morning star'.

Now suppose we substitute 'the evening star' into this statement as follows: 'the morning star is identical to the evening star'. This also turns out to be true, but for quite different reasons. The substitution has not preserved intension. We must learn some astronomy to determine that this statement is true; we must learn that, as a matter of fact, 'the morning star' and 'the evening star' refer to the same object. We needed no astronomy to determine that the tautology was true; we know that everything is self-identical. Therefore, if two expressions are coextensional, their substitution one for the other does not preserve intension.

It follows from our consideration of extensions and intensions that a statement in an argument may be unclear because the extension or the intension of a term or terms in that statement is unclear. For example, consider the following statements:

> 'There is rational and viable evidence that many cases of psychosis, from schizophrenia to dementia praecox, could be ascribed to the phenomenon of "possession" by an alleged spirit that refuses to accept the fact that he or she is dead', and
>
> 'The spirit, whether good or bad, is said to be "incorporated" in the living body of a receptive person.' (Fuller, p. 7)

There are several unclear terms in these two statements which must be clarified as much as possible before they are used in statements of evidence in inductive arguments, or in statements involving logical relations in deductive arguments. This uncertainty can be seen by asking questions like "What is the extension of 'rational and viable evidence'?" "Does it include the claims of mediums?" "What is its intension?" "What is the intension of 'spirit'?" "What is the extension?" "Do spirits refuse to accept facts?" "What is the intension of 'refuses to accept a fact'?" "What is the intension of 'receptive person'?" "Does its extension include members of the traveler's aid society?" These questions and the absence of clear answers to them, given the passage, show that we do not understand the argument well enough to evaluate it. Often, however, our evaluation may simply be that the terms have no clear intension, and that, therefore, arguments using these unclear terms are simply no good.

Such no good arguments are said to contain improperly vague or ambiguous terms. Properly vague terms like 'bald' can be used clearly without being able clearly to specify its extension. However, improperly vague terms have no clear intension. For example, 'spirit' considered above is an improperly vague term. A term, in a given context, is said to be ambiguous when we are unable clearly to determine which of the possible extensions or which of the possible intensions of the term is being used. For example, 'incorporated' as used above is an ambiguous term.

The notions of extensionality and intensionality help us understand other confusions which must be recognized or clarified before we can proceed with conceptually significant criticism of conceptually significant arguments. Often, however, we must be content to point out that the extensions and intensions of terms and statement used in some arguments cannot be determined and that, therefore, the arguments are not conceptually significant and can be relegated to the rubbish.

Models

Clearly distinguish vagueness from abmiguity. Provide examples of arguments with improperly vague and ambituous terms (anticipate our discussion of fallacies in Section 5). Point out that many are so unclear as to be conceptually insignificant, but that others, while unclear, may be clarified somehow (anticipate our discussion of definition and explication in Subsections 5 and 6).

Exercises

1. Given D.(1) and D.(2), P.(1) and P.(2), provide all the true principles you can about intensionality and extensionality.

2. Give the students a list of statements and ask them to point out the vague, improperly vague, and ambiguous terms. Have them explain why each is vague, improperly vague, or ambiguous in terms of extensions and intensions.

<u>Subsection 3 - Equivocal Uses of Terms</u>

As well as being unclear because its terms are unclear, statements in arguments may also be unclear because of what we shall call the equivocal use of a term or terms in the statements. The equivocal use of a term involves confusing different intensions or extensions of the same term. For example, consider the following argument:

3.1

1. The <u>end</u> of a thing is its perfection.
2. Death is the <u>end</u> of life.

∴ 3. Death is the <u>perfection</u> of life.

In premise 1, 'end' is used to mean 'good', but in premise 2, 'end' is used to mean 'termination'. In this case, different intensions of the same term are confused. Therefore, if we were capturing the logical form of this argument, we could not correctly translate both occurrences of 'end' using the same predicate constant 'E'; we instead distinguish the non-cointensional senses of 'end' by using, for example, 'G' for 'end' in premise 1 and 'T' for 'end' in premise 2 in accordance with our rule that predicate constants be used univocally. Therefore, when correctly capturing the logical form of this argument by recognizing the equivocal use of 'end', we can see that the argument is not deductively valid.

Models

1. Review briefly our requirement that propositional constants and predicate constants be used univocally. Point out why we specified this as a requirement for translation of an argument's logical form into PC and LPC.

2. Provide examples from the reading of equivocation (anticipate our discussion of informal fallacies in Section 5).

3. Point out that an argument that depends on an equivocal use of a term to support the conclusion is intuitively not conceptually significant. Explain why this is so and consider examples from Fuller. Consider 'surgery'.

Exercises

1. Present a series of arguments involving the equivocal use of terms, either from the reading or from logic texts. Have the students correctly capture their logical form and point out the equivocal use of a term or terms.

2. Have the students write a paper in which they argue that 'cure' is used equivocally by faith healers (this will anticipate our discussion of definition and explication).

Subsection 4 - Psychological Contexts

Arguments are sometimes unclear because of errors resulting from the failure to notice the presence of what we shall call psychological contexts. By 'psychological contexts', we shall mean statements containing the expressions 'is aware that', 'believes that', 'is so called', 'says that', 'knows that', 'doubts that', or others containing what we might intuitively call psychological expressions. Many uses of such psychological contexts are clear and unproblematic. For example,

4.1

1. I am aware that the Earth travels around the Sun and I am aware that the Moon travels around the Earth.

:. 2. I am aware that the Moon travels around the Earth.

However, the failure to understand and correctly deal with psychological contexts can lead to the construction of deductively invlaid arguments. Consider the following example of a deductively invalid argument:

4.2

1. Bigfoot is so called because he wears size 15 shoes.

2. Bigfoot is Jim Wilson.

:. 3. Jim Wilson is so called because he wears size 15 shoes.

The problem with this argument involves premise one. Premise one, for the purpose of a deductive argument, should be translated as "'Bigfoot' is used to refer to Jim Wilson because he wears size 15 shoes." Thus, correctly translated, the conclusion 3 does not follow deductively from 1 and 2. However, other deductive arguments using psychological contexts are more difficult and demand more attention.

Suppose that we are attempting to translate and evaluate the validity of an argument containing as a premise, the statement

(i) s believes a = the President of the United States, where s is a person and a is another person. Let P stand for 'President of the United State'. Given our discussion of translating definite descriptions into our logical symbols, we can translate (i) in two ways, which we shall call small scope and large scope.

(ii) $(\ x)\ [(\forall y)(Py \equiv y = x)\ .\ s \text{ believes } a = x]$, or

(iii) $s \text{ believes } (\ x)\ [(\forall y)(Py \equiv y = x)\ .\ a = x]$

Here (ii) is called small scope since the scope of the belief is limited to a = x. A statement with this logical form is false either if there is no x that is P, or if there is more than one of them.

Here (iii) is called large scope since the scope of the belief covers the entire statement. A statement with this logical form may be true even if there is no x that is P, or even if there is more than one of them. The implications of this psychological context for an argument can be seen as follows.

Suppose that:

(iv) b = President of the United States.

Here (iv) is translated in our symbols as:

(v) $(\exists x)\ [(\forall y)(Py \equiv y = x)\ .\ z = b]$

Suppose that we use (ii) and (v) as premises in a deductive argument as follows:

4.3

1. $(\exists x)(\ (\forall y)(Py \equiv y = x)\ .$ s believes $a = x)$
2. $(\exists x)(\ (\forall y)(Py \equiv y = x)\ .\ b = x)$

$\therefore$ 3. s believes a = b

Also suppose that we use (iii) and (v) as premises in a deductive argument as follows:

4.4

1. s believes $(\exists x)((\forall y)(Py \equiv y = x)\ .\ a = x)$
2. $(\exists x)((\forall y)(Py \equiv y = x)\ .\ b = x)$

$\therefore$ 3. S believes a = b

Neither 4.3 nor 4.4 are valid deductive arguments, and both represent a logical error that results from failing to notice the presence of a psychological context.

Consider 4.3. The first premise is a small scope translation of the statement 's believes that a is identical with the President of the United States'. The second premise is a translation of the statement 'b is identical with the President of the United States'. The second premise makes no claims about s's beliefs. Therefore, we can see that it is logically possible for the premises to be true and the conclusion, the statement 's believes that a is identical with b', to be false; b may, in fact, be identical to a, but s may not, in fact, believe it. Therefore, 4.3 is an invalid argument which ignores "s believes." The problem here is that believing is not a truth functional relation. That is, the truth value of statements involving 'believes' and other statements is not always determined by considering the truth values of the component statements.

The same problem arises with 4.4 that arises with 4.3. The first premise is a large scope translation of the statement 's believes that a is identical with the President of the United States'. The second premise again, is a translation of the statement 'b is identical with the President of the United States'. The second premise makes no claims about s's beliefs. Again, we see that it is logically possible for the premises to be true and the conclusion to be false; b may, in fact, be identical to a, but s may not, in fact, believe it. Therefore, 4.4, like 4.3, is an invalid argument ignoring "s believes."

Both 4.3 and 4.4 may be confused with the following valid argument:

4.5

	1.	$(\exists x)(\forall y)((Py \equiv y = x) \,.\, a = x))$
	2.	$(\exists x)(\forall y)((Py \equiv y = x) \,.\, b = x))$
$\therefore$	3.	$a = b$

Argument 4.5 is a valid deductive argument which can be proved so by using our rules of inference. The context here is clear, and there is no logical problem with 4.5:

	1.	$(\exists x)(\forall y)(Py \equiv y = x) \,.\, a = x)$	given A
	2.	$(\exists x)(\forall y)(Py \equiv y = x) \,.\, b = x)$	given A
c	3.	$(\forall y)(Py \equiv y = c) \,.\, a = c$	1, for EQE
	4.	$(\forall y)(Py \equiv y = d) \,.\, b = d$	2, for EQE
d	5.	$(\forall y)(Py \equiv y = c) \,.\, a = c$	3, R
	6.	$(\forall y)(Py \equiv y = d)$	4, .E
	7.	$(\forall y)(Py \equiv y = c)$	5, .E
	8.	$Pa \equiv a = d$	6, UQE
	9.	$Pa \equiv a = c$	7, UQE
	10.	$a = c$	5, .E
	11.	Pa	9, 10, $\equiv$ E
	12.	$a = d$	8, 11, $\equiv$ E
	13.	$b = d$	4, .E
	14.	$a = b$	12, 13, = I
	15.	$a = b$	4, 14, EQE
	16.	$a = b$	3, 15, EQE

Other deductive arguments that involve psychological contexts may be deductively valid, but evaluated as unsound because of the psychological context. For example:

4.6

1. If I believe in God, then God exists.
2. I believe in God.

∴ 3. God exists.

1. $BP \supset Q$
2. BP

∴ 3. Q

Let 'BP' stand for 'I believe in God' and let 'Q' stand for 'God exists'. Therefore, 4.6 is a valid argument, a simple instance of $\supset$E. However, it is unsound; premise 1 is false, since nothing follows about God's existence from one's beliefs. In this case, the psychological context causes a problem for soundness, not for validity.

It is useful to note the difference between 4.6 and the following argument which is invalid because of the presence of a psychological context:

4.6'

1. I believe if I believe in God, then God exists.
2. I believe in God.

∴ 3. God exists

1. $B\ (BP \supset Q)$
2. BP

∴ 3. Q

Therefore, 4.6' is not a valid argument since in premise 1 the entire conditional is what is believed.

This failure to recognize the presence of psychological contexts can also lead to the construction of inductively weak arguments. Consider the following inductively weak argument:

4.7

1. Charles Hickson claims he was taken aboard a flying saucer from another galaxy.
2. Calvin Parker believes he was taken aboard a flying saucer from another galaxy.
3. Hundreds of other people claim to have been in contact with beings from another galaxy who fly in flying saucers.

∴ 4. Beings from another galaxy have visited Earth in flying saucers.

On an intuitive level, we might procede as follows. Consider (1). Even if this is true, he could be mistaken, deliberately lying, drunk for his experience, mentally ill, or seeking publicity. Therefore, (1) is not evidence for (4); $P(4/1) \leqq P(\sim 4/1)$. Consider (2). Even if this is true, he too could be mistaken, deliberately lying, drunk for his experience, mentally ill, or in collusion with Hickson. Therefore, (2) is not evidence for (4). Consider (3). Even if this is true, these people could be fooled by hoaxes, under the influence of drugs, deliberately lying, or attempting to gain publicity. Therefore, (3) is not evidence for (4). Consider intuitively the results: (1), (2), and (3) are all not evidence for (4), so P (4/1 . 2 . 3) $\leq$ P ($\sim$ 4/1 . 2 . 3). Therefore, this shows that 4.7 is a weak inductive argument.

The reason that 4.7 is such a weak inductive argument is that each of the premises involve a statement of a belief that a person has, or a statement of a claim that a person makes. From such true statements, nothing follows about the existence of the objects of belief, or about the existence of the referents that the claims concern. From the stated belief or claim, we cannot infer that the objects of belief have existing referents, or that the claims are claims about existing referents. Thus, it may be true that Hickson and hundreds of people make those claims, and it may be true that Parker believes that he was taken aboard a flying saucer from another galaxy. However, it may at the same time be false that flying saucers from another galaxy exist. Since we have determined that 4.7 is inductively weak, we know that 4.7 is a no good argument.

Psychological contexts, therefore, must be recognized when used in both deductive and inductive arguments. Failure to do so often results in a failure to recognize invalid or unsound deductive, and inductively weak inductive arguments.

Models

1. Present examples of deductive arguments involving psychological contexts. Point out the role of epistemic logics to deal with 'knows'. For example, consider the following:

    1. Jimmy Olson believes that Superman can bend steel with his bare hands.

    ∴ 2. Jimmy Olson believes that Clark Kent can bend steel with his bare hands.

    Discuss and give examples of "quantifying in" to what Quine called referentially opaque contexts.

2. Present examples of inductive arguments involving psychological contexts.

3. Point out when their presence is a problem for a conclusion of an argument and when their presence is not a problem for a conclusion of an argument.

Exercises

1. Have the students capture the logical form of statements of the form "s believes a = b." Provide examples from the reading. Then provide additional premises of the form "b = c" and have them attempt to prove that the arguments are valid, or they are invalid.

2. Have the students capture the logical form of inductive arguments involving psychological contexts. (Consider examples from Blum.) Have them show that they are inductively strong or inductively weak.

Subsection 5 - Clarifying Unclear Terms by Definition

We have seen that an author's inattention to the logical form of arguments, the unclear intensions or extensions of terms or statements, the equivocal uses of terms, and the inattention to psychological contexts can result in unclear arguments, which must, where possible, be clarified in accord with the principle of charity before conceptually significant criticism can occur. Of course, many such arguments cannot be clarified, and it is sufficient to evaluate these conceptually insignificant arguments by pointing out the above errors.

Having considered methods for clarifying the logical form of logically unclear arguments, we shall now consider methods for clarifying unclear terms and for the evaluation of such proposed clarifications.

One way to clarify an unclear term is to provide a definition of the term. Intuitively, however, simply providing a definition for a term does not necessarily mean that we have successfully clarified the term. The definition may simply be no good, or may simply reflect the unclarity of the term. Therefore, we must also understand how to evaluate proposed definitions, and we must understand the limitations and serious problems involved with providing and evaluating definitions. Providing and evaluating definitions of a term involves providing and evaluating specific claims about the term's extension or the term's intension. We shall begin by proposing what we shall call definition by extensional equivalence, and showing that definition by extensional equivalence does not succeed in defining a term. In attempting to fix this defect, we shall show that while there are many different accounts of the function and evaluation of many different kinds of definitions, there are serious limitations and philosophical problems with providing an account of definition.

What may be called definition by extensional equivalence relies on one of the logical connections, the biconditional ($\equiv$). The biconditional connects a statement of term or phrase to be defined, called the definiendum, with a statement defining the term or phrase, called the definiens. Providing this biconditional connective between the definiendum and the definiens can be called definition by extensional equivalence because the biconditional can be viewed as asserting that the definiens and the definiendum are coextensional. Consider the following example:

5.1 X is a UFO $\equiv$ x appears to be an aerial phenomenon for which we have no specific, certain explanation.

Definition 5.1 asserts that appearing to be an aerial phenomenon for which we have no specific, certain explanation is both a necessary and a sufficient condition for being a UFO. In other words, all and only those objects that are in the extension of the definiens are in the extension of the definiendum.

To evaluate a definition like 5.1, we must simply consider whether, in fact, all and only those objects that are in the extension of the definiens are in the extension of the definiendum. That is, we attempt to find an object that is either clearly in the extension of the definiens and clearly not in the extension of the definiendum, or clearly in the extension of the definiendum and clearly not in the extension of the definiens. Finding such an object is called providing a counterexample to the proposed definition. We can see that this process is similar to the process of inductive elimination.

Consider the following example of a proposed definition and its evaluation by counterexample:

5.2 x is an automobile $\equiv$ x is a four-wheeled, motorized vehicle.

To evaluate 5.2, we must consider whether, in fact, all and only those objects that are in the extension of the definiendum are in the extension of the definiens. For 5.2, we can easily find an object that is clearly in the extension of the definiens that is clearly not in the extension of the definiendum. For example, consider a fork-lift, or a farm tractor, or a garden tractor, or a riding lawnmower. These objects are four wheeled motorized vehicles, yet they are not automobiles. These objects are all counterexamples to the proposed definition. One counterexample, however, is sufficient to show that it is not the case that all and only those objects that are in the extension of the definition are in the extension of the definiens. Therefore, by providing such a counterexample, we have show that 5.2 is not a good definition by extensional equivalence of 'automobile'. The definiendum and the definiens are not coextensional.

This means of evaluating given definitions by extensional equivalence also gives us a means for providing such definitions. We attempt, in initially providing the definition, to provide a definiens that is coextensional with the definiendum. We then reflect on this initial definition and search for counterexamples. Finding counter-examples, we then modify the definiens to eliminate the counterexamples, thus building a definition in which the definiens is coextensional with the definiendum.

Consider the following example of this procedure. Suppose that we are attempting to provide a definition by extensional equivalence for the term 'brother'. We may propose the following:

5.3 x is a brother $\equiv$ x is a male relative.

Being a male relative is certainly a necessary condition of being a brother, but it is not a sufficient condition. For example, an uncle, a father or a grandfather, are all clearly male relatives, yet not all are brothers. These are counterexamples to 5.3 which we must rule out. Thus we may consider revising 5.3 as follows:

5.3' x is a brother $\equiv$ x is a male relative that is not a father or a grandfather.

Yet 5.3' also has counterexamples. Consider a male cousin, a nephew, a grandson, a son, or a great uncle. Therefore, 5.3 also fails as a definition. We can see from these counterexamples that to rule out each male relative that is not a brother will be a long process indeed. We must rule great-great-great-grandfathers, great-great-great-uncles, etc. Therefore, we might consider the uniqueness of being a brother, and revise 5.3' as follows:

5.3" x is a brother $\equiv$ x is a male sibling.

Definition 5.3" does not have counterexamples, and clearly the definiens and definiendum are extensionally equivalent. Therefore, according to the procedure for evaluating such definitions, 5.3" is a good definition.

However, this procedure points to a serious problem with this account of definition. By reflecting carefully, we can see that there are problems with this procedure for evaluating definitions by extensional equivalence that lead us to conclude that what has been called definition by extensional equivalence is not a workable form of definition. While 5.3" is a good definition, it is not a good definition simply because the definiens and definiendum are extensionally equivalent (coextensional). Consider the following biconditional to clarify the nature of this problem:

5.4 x is a creature with a heart ≡ x is a creature with a kidney.

Clearly, upon sufficient reflection, we can see that the definiens and the definiendum are coextensional. However, 5.4 is designed to show that simply requiring coextensionality is not sufficient to guarantee a good definition. In fact, we don't want to say that 5.4 is a definition at all. The problem, then, is to rule out biconditionals like 5.4 as definitions and rule in biconditionals like 5.1 and 5.3" as definitions.

We may consider introducing an appeal to intensions here, and argue that what we have called a good definition by extensional equivalence provides a definiens that is both coextensional and cointensional with the definiendum. Thus, we might attempt to solve this problem by abandoning the attempt to provide definitions by extensional equivalence and instead, adopt the attempt to provide definitions by intensional equivalence. This automatically accounts for extensional equivalence because of the following principle:

P.(3) If a term A is cointensional with a term B, then A is coextensional with B.

Thus, we might argue, 5.1 is a good definition by intensional equivalence because the definiens and the definiendum are cointensional, just like 5.3" is a good definition by intensional equivalence because the definiens and definiendum are cointensional.

However, by reflecting carefully, we can see that there are problems with this procedure for evaluating definitions by intensional equivalence. The first and most obvious problem is how to determine whether or not a proposed definiens is, in fact, cointensional with a given definiendum. However, there is a more serious problem. Consider the following biconditional to clarify this more serious problem:

5.3 x is a brother $\equiv$ x is a brother.

Clearly, the definiens and the definiendum of 5.5 are cointensional. Therefore, by our principle P.(3), they are coextensional. So 5.5 is a good definition by intensional equivalence. However, we do not want to say that 5.5 is a good definition. The problem we now face is to rule out biconditionals like 5.5 as definitions and to rule in biconditionals like 5.1 and 5.3" as definitions.

We may consider introducing an appeal to some notion of informativeness, and argue that what we have called a good definition by intensional equivalence provides a definiens that is both cointensional with the definiendum and informative. In fact, many philosophers such as G. E. Moore have attempted to provide specific conditions for informativeness. However, these are deep and murky problems for philosophers to solve, well beyond the boundaries of our present purpose. It is sufficient for our purposes to notice that these problems arise in attempting to explain how to provide and how to evaluate such definitions.

We must, for our purposes, avoid these problems by carefully considering and screening candidates for definiendums. We are relatively safe with definiendums that have a clear extension and a clear intension. However, the price of this safety is often conceptual in significance. Often, the unclear terms in the argument that need clarification by definition do not have clear extensions, or intensions, and this is why they need clarification. For example, the extension of 'dead' is all dead things, yet the problem is that it is not always clear which objects fit this extension and which do not.

Often the best we can do, while avoiding the above problems with definitions, is to provide what are called dictionary definitions.

5.6 x is a dictionary definition of y $\equiv$ x correctly reflects current usage of y and x is cointensional with y.

Such definitions are easily evaluated. Where current usage clearly applies a term to some object, a good dictionary definition may not withhold it; where current usage clearly withholds a term from some object, a good dictionary definition may not apply it.

Yet while dictionary definitions may be helpful as reports of linguistic usage, often they simply capture the unclarity that we are attempting to avoid by providing the definition.

Therefore, such definitions are not helpful completely to clarify terms which must be clarified to proceed with evaluations of conceptually significant arguments. To provide the necessary clarification of such terms, we must abandon definition altogether and adopt what we shall call explication.

Models

1. Formulate several definitions by extensional equivalence, and show how counterexamples are formulated. Reemphasize the problems that lead us to introduce definition by intensional equivalence, and show that extensional equivalence fails to provide a workable account of definition.

2. Discuss 'informativeness' and attempt to formulate conditions of informativeness in class. In more advanced groups, you might discuss the problem of analysis.

3. Consider discussing other commonly used "definitions" like stipulative definitions and operational definitions. Stipulative definitions can be show to be either formulated and evaluated for systematic clarity, or to be what we shall call explications. Operational definitions can be shown not to be definitions, much like what have been called definitions by extensional equivalence can be shown not to be definitions. Consider dictionary definitions and explain how dictionaries are written.

4. Consider proposing and evaluating dictionary definitions and point to their limitations in clarifying unclear terms.

Exercises

1. Have the students formulate counterexamples to proposed definitions by extensional equivalence. (This may be made up from terms in the reading.)

2. Have the students formulate counterexamples to proposed descriptive definitions.

3. Have the students write a paper in which they are asked to explain why descriptive definitions are not always useful in clarifying unclear terms in an argument. Have them provide an example.

<u>Subsection 6 - Clarifying Unclear Terms by Explication of the Unclear Property or Concept</u>

As we shall see, explications avoid the problems we considered that face definitions. We may, therefore, appeal to explications to clarify unclear terms, and thereby, to allow us to proceed with evaluations of conceptually significant arguments. We must, therefore, consider how to propose and how to evaluate explications.

In providing an explication, we provide an explication of a property, or concept, not an explication of a term. It is the nature of properties or concepts that they cannot be changed; that is, they are objective. Intuitively, we can see this by seeing that the same property or concept can be apprehended as the same by different people. Recall that properties are the intensions of predicates and that concepts are intensions of individual terms. To explicate a property or concept, we replace this original property or concept called the explicandum with another property or concept called the explicatum. While, as we have seen in a definition, the definiendum and the definiens are coextensional or cointensional, in an explication, the explicandum and explicatum are neither coextensional nor cointensional. Clearly then, the process of explication is distinguished from the process of definition. We shall also see that explications are proposed and evaluated differently from definitions.

We can begin our consideration of explication by intuitively understanding the purpose for replacing one property or concept with another. We often use explication to replace one property or concept (the explicandum) with another property or concept (the explicatum) when the explicandum does not usefully serve some conceptual purpose as the explicatum. We can intuitively see this by considering an analogy offered by Rudolf Carnap, in which the explicandum is compared to a pocket knife and the explicatum is compared to a scalpel. While the pocket knife is a handy instrument, useful for many pruposes, it is not as well suited to open heart surgery as the scalpel. Consequently, we lay down the pocket knife and pick up the scalpel when we do open heart surgery, since we can accomplish our purpose better with a scalpel than with the pocket knife. By analogy, while the explicandum may be a handy property or concept, useful for many conceptual purposes, it is not as well suited to a specific conceptual task as the explicatum. Consequently, we adopt the explicatum for this specific conceptual task, and cast aside the explicandum since we can accomplish our purpose better with the explicatum than with the explicandum.

With this in mind, we can consider the steps involved in providing an explication of a property or concept. Consider, for example, the concept expressed by 'fish' as a candidate for explication. The first step in providing an explication is to determine if the concept to be explicated is, in fact, an explicandum; that is, to determine if the concept is sufficiently clear to be suitable for explication. To do so, we must provide an informal clarification of the concept by informal explanations and examples. For example, an informal clarification of the property expressed by 'fish' might include an informal explanation like "lives in the water; spends most of its time in fresh or salt water," etc., and an example of something that clearly has the property like "Charlie the Tuna." Since the property expressed by 'fish' can be informally clarified, we can conclude that the property expressed by 'fish' is an explicandum.

Once we have determined that we have an explicandum, the next step is to provide the explication of the explicandum in light of the specific conceptual purpose at hand. For example, the explicandum of 'fish' serves certain clearly recognizable purposes (like the pocket knife). For example, it serves to distinguish creatures that live in water from creatures that live on land. Yet if our purpose is to classify and order groups of living things clearly, in ways that may allow us to investigate how various groups of living things evolved, then the explicandum fails to serve this purpose well. Therefore, to serve this purpose better, we introduce a new property, the explicatum, that serves similar purposes as the old property, the explicandum, but that also serves this new purpose.

Providing the explicatum is, to some extent, simply a matter of ingenuity. Strictly sepaking, there is no correct or incorrect explicatum. However, not all explicata are equally justified for a given conceptual purpose, as we shall see. For the explicatum of 'fish', in light of the above conceptual purpose, consider 'member of the class Pisces'. This explicatum of 'fish' does allow us to classify and order groups of living things clearly, in ways that allow us to investigate how various groups of living things evolved, while the explicandum does not allow us to do this. For example, the explicandum of 'fish' includes whales and porpoises. However, the explicatum of 'fish' does not include whales and porpoises.

However, substituting the explicatum for the explicandum in certain statements does preserve truth value in certain, intuitively desirable extensional contexts. For example, consider the statement 'Charlie the Tuna is a fish'. This statement is true for both the explicandum of 'fish' and the explictum of 'fish'. However, consider the statement 'Moby Dick is a fish'. This statement is true given the explicandum of 'fish', but false given the explicatum of 'fish'. This is certainly not a defect of the explicatum; the explicatum serves to introduce a certain precision and care for the purpose of classifying and ordering groups of living things clearly. Therefore, we are entitled to say, given the explicatum, that 'Moby Dick is a fish' is simply false.

We can see, therefore, that while the explicatum must preserve some extensional overlap with the explicatum, there is no requirement that the explicatum be coextensional with the explicandum. As we have seen, the explicatum of 'fish' and the explicandum of 'fish' are not coextensional. We must also note that often in a given context, for a given purpose, the explicatum need not be the one with the most extensional overlap. For example, 'swims with appendigial fins' as a proposed explicatum of 'fish' has far more extensional overlap with the explicandum of 'fish' than 'member of the class Pisces'. However, it fails as an explicatum, given the purpose of classifying and ordering groups of living things clearly, since it fails fruitfully to advance this purpose. Therefore, while strictly speaking, there are no correct or incorrect explicata, we are certainly in a clear position to evaluate and discard proposed explicata given their failure fruitfully to advance a given purpose.

We have similarly understood recognizing the need for an explication. In providing 'member of the class Pisces' as an explicatum of 'fish' in this context, we are not avoiding the problem of the correct descriptive definition of 'fish' (which has since changed). In not using a pocket knife and using a scalpel, we are not avoiding the problem of the correct use of a pocket knife; we are simply in a position to say that a pocket knife is not useful for open heart surgery, and a scalpel is useful for this purpose. Analogously, in not using a descriptive definition, or an explicandum, and using an explicatum, we are not avoiding the problem of the correct use of a definition or an explicandum; we are simply in a position to say that a definition, or an explicandum is not useful for this specific conceptual purpose, and that an explicatum is more useful for this purpose.

We shall now consider several examples of providing and evaluating explications. First, let us summarize the steps involved in providing and evaluating explications. These are meant to be suggestive guidelines, not a formal recipe or a decision procedure.

1. Determine if the property or concept to be explicated is sufficiently clear to be an explicandum by: a) providing an informal clarification of the property or concept and by b) providing informal examples. Failure clearly to do a) or b) and showing that a) or b) cannot be done is sufficient to show that the property or concept to be explicated is too unclear for explication, and is, therefore, without cognative significance.

2. Determine the specific conceptual purpose at hand by asking and answering the question "Why is the explicandum not as useful in this context as a different concept?"

3. Choose or evaluate the explicatum in reference to this specific conceptual purpose by: a) determining that there is at least some extensional overlap between the explicandum and the explicatum, by b) determining that the substitution of the explicatum for the explicandum

> in certain statements preserves truth value in desirable extensional contexts, and by c) determining that the explicatum fruitfully advances the specific conceptual purposes at hand.

We shall now work through two examples. Consider, in the context of John G. Fuller's explanation of Arigo's healing powers, the statements:

> "It was alleged that Arigo claimed he incorporated <u>the spirit</u> of a deceased German doctor, whom he identified as Dr. Adolpho Firtz . . . it was Dr. Fritz, a German physician who had died in 1918, who provided the instantaneous diagnosis." (Fuller, p. 22)

Suppose that we are attempting to understand what it is for a "spirit to be incorporated" into a living person. Therefore, we proposed to explicate 'spirit' to enable us to understand and then evaluate Arigo's alleged claim. First, however, we must determine if the concept expressed by 'spirit' is sufficiently clear to serve as an explicandum. To do so, we attempt to provide an informal clarification of the concept and informal examples. Suppose that spirit is a concept of the mind of a human being. This does not help because it seems that a mind is able to function only in conjunction with its body. There is nothing to indicate that minds can move from body to body. This concept, therefore, does not help us to clarify the concept of spirit as used here. Suppose that the concept is a concept of the influence of one human mind on another. This does not help because for one mind to influence another, there must be some form of contact. For example, one person using his mind for teaching, writing, or speaking, and another person correspondingly using his mind for learning, reading, or listening. Since Fritz died in 1918 and Arigo was born in 1923, the contact would have to be written. However, Fritz wrote nothing and Arigo was illiterate, so this does not help to clarify this concept.

We can begin to see that 'spirit' is not a good candidate for explication, since we are unable to provide an explicandum by informally clarifying the concept. Therefore, we are entitled to conclude that the concept in this context is too unclear for explication, and is, therefore, without cognitive significance.

Explication is, however, useful when an author's use of a term expressing a explicandum is not as well suited to the author's apparent purpose as some other concept. In the context of Charles Berlitz's fifth chapter entitled "Is There a Logical Explanation?", consider the following statement:

> "Lacking a logical and readily acceptable explanation, independent researchers concerned with the disappearances in the Bermuda Triange have gone even further afield - some to explanations based on exceptions to natural law, others to suggestions of interdimensional changes through a passageway equivalent to a "hole in the sky" . . . others believe the disappearances are engineered by entities from inner or outer space, while still others offer a theory or combination of theories that the phenomenon may be essentially caused by still functioning man-made power complexes belonging to a science considerably older and very different from ours." (Berlitz, p. 120)

Consider 'logical explanation' in this context. Berlitz's use of 'logical explanation' does not allow us clearly and precisely to specifiy which explanations count as logical explanations and which explanations do not count as logical explanations and why they do or do not. Clearly, Berlitz does not simply mean to distinguish explanations which violate the laws of deductive logic or inductive logic from explanations which do not. We might, therefore, consider 'logical explanation' in this context as a candidate for explication.

First, we must determine if the concept expressed by 'logical explanation' is sufficiently clear to be an explicandum. The concept seems to be a concept of a good explanation, or an explanation that is commonsensical. Consider, for example, the statement 'there is a logical explanation for my missing car keys'. We, therefore, have a clear case of an explicandum.

Now we must determine the specific conceptual purpose at hand. We may do so by asking why the explicandum is not as useful in this context as some other concept. The answer is that the explicandum does not allow us to determine on what grounds we determine that an explanation is a good explanation and on what grounds we determine that an explanation is a no-good explanation. Therefore, the purpose for replacing the explicandum with an explicatum is to allow us to better classify explanations as good or no-good on precise grounds.

We must now consider the selection of an explicatum, given this specific conceptual purpose in this context. Let's consider first our earlier rejected proposal, the concept expressed by 'an explanation that does not violate the laws of deductive or inductive logic'. This clearly allows us to classify good and no-good explanations on precise grounds. However, it does not allow us to distinguish good and no-good explanations in a way that is useful in this context. For example, we can inuitively see that an explanation that is not logical, in the sense that is expressed by the concept of the negation of the explicandum, may at the same time not violate the laws of deductive or inductive logic. That is, we can have explanations that are not 'logical explanations' in Berlitz' sense, yet are explanations that do not violate the laws of deductive or inductive logic. Therefore, this proposed explicatum is not useful for this purpose.

To arrive at an explicatum for 'logical explanation', let's consider what may be classified as not logical explanations in Berlitz' sense. These can be found in the selection from Chapter 5, quoted above, and presented as sufficient conditions for not logical explanations which we shall simply call illogical explanations:

6.1 given x is an explanation:

a) if x entails that the world is such that the laws of nature may not hold, then x is an illogical explanation.

b) if x entails that the world is such that there are "holes in the sky," then x is an illogical explanation.

c) if x entails that the world is such that creatures living in inner space from Atlantis exist, then x is an illogical explanation.

d) if x entails that the world is such that creatures living in outer space exist, then x is an illogical explanation.

e) if x entails that the world is such that ancient, advanced technology's power sources exist, then x is an illogical explanation.

We can see that 6.1 classifies as illogical any explanation which entails the existence of things that are not known to exist. Berlitz, therefore, seems to provide an ontological basis to determine that an explanation is illogical. Applying the appropriate negations, then, we can see that a likely explicatum of 'logical explanation' will be a concept of an explanation that does not entail the existence of things not known to exist.

We can see that adopting this explicatum will allow us successfully to classify explanations in this context as good or no-good on precise grounds consistent with Berlitz' view. For example, an explanation proposed to explain the disappearance of my car keys that entails that elves exist is not a logical explanation, but one that does not entail the existence of things not known to exist is a logical explanation. The explicatum seems to preserve truth value in contexts provided by Berlitz, and seems fruitfully to advance the purpose of allowing us clearly to distinguish, according to Berlitz' view, logical from illogical explanations. Therefore, this explicatum is successful.

It is important to note that in the above example, we have provided an explicatum to clarify a concept on Berlitz' behalf. We may now, of course, having explicated his concept of a 'logical explanation', evaluate his use of the explicated concept and even argue that such a concept is not useful enough for evaluating all the explanations we must consider. This indeed involves conceptually significant criticism. The explicatum provided on Berlitz' behalf can be seen as an instance of the principle of charity. We must, therefore, briefly consider the role of definition and explication in evaluating arguments.

Models

1. Provide and evaluate several explications of concepts from the reading on behalf of the author. For example, consider explicating 'cure', 'surgery', and 'diagnosis' as used by Fuller in his account of Arigo's activities. Point out that these terms may be used in ways that depend on their descriptive definition, and not the explicatum, and that this leads to the problem of equivocation we considered earlier.

2. Discuss the use of explication to clarify terms, and thereby avoid equivocations in arguments.

Exercises

1. Have the students provide an explication of the concept expressed by 'conceptually significant argument', as we have used it in this course.

2. Have the students provide and evaluate explications on behalf of Berlitz, Fuller, Blum, and VonDänigan. Consider explicating:

   a) Mystery - for Berlitz
   b) Disappearance - for Berlitz
   c) Space-time warp - for Berlitz
   d) Prescription - for Fuller
   e) Established fact - for Fuller
   f) Possession - for Fuller
   g) Signal - for Blum
   h) Legend - for VonDänigen

Subsection 7 - The Reconstruction and Evaluation of Arguments

This discussion of definition and explication has two obvious applications to the evaluation of arguments. The first obvious application of our brief consideration of definition and explication to the evaluation of arguments is to evaluate an argument as no good because a definition of a term has a counterexample, or an unclear term cannot be explicated and, therefore, is not cognitively significant. (This is often straight forward, but sometimes it is more difficult to detect.) The second obvious application of our brief consideration of definition and explication to the evaluation of arguments is to evaluate definitions or explications given in arguments, according to the procedures briefly outlined above. However, this discussion of definition and explication has a less obvious and more difficult application to the evaluation of arguments.

We mentioned this less obvious application of explication to the evaluation of arguments when we explicated Berlitz' concept of a 'logical explanation'. This application of explication to Berlitz' arguments is an example of a step in what we shall call the reconstruction of an argument. The reconstruction of an argument can be understood in terms of the principle of charity; a reconstruction of an argument that is consistent with the author's expressed or implied views. Given a reconstructed argument, we are in a position to provide that we have intuitively referred to as a conceptually significant critical evaluation.

The reconstruction of an author's argument involves clarifying the argument by clarifying its logical form, by clarifying the intensions or extensions of terms by eliminating improper vagueness or ambiguity where possible, by clarifying equivocations where possible, or clarifying psychological contexts where possible, by clarifying terms by providing definitions where possible, or by clarifying an author's concept by providing explications where possible. We may evaluate such reconstructions by asking if the proposed reconstruction is consistent with the author's expressed or implied views. We may thereby apply the material we have considered in this section to provide reconstructions of given arguments and then critically evaluate the reconstruction according to the rules of deductive or inductive support to determine if the premises support the conclusion.

Consider the following example of such a reconstruction and its evaluation. E. J. Ruppelt, in his book The Report on Unidentified Flying Objects, in arguing for the existence of UFO's, states:

> 7.1 "What constitutes proof? Does a UFO have to land at the River Entrance to the Pentagon, near the Chief's of Staff offices? Or is it proof when a ground radar system detects a UFO, sends a jet to intercept it, the jet pilot sees it and locks on with his radar, only to have the UFO streak away

> at phenomenal speed? Is it proof when a jet pilot fires at a UFO, and sticks to his story even under threat of court-martial?" (Berlitz, p. 131).

In providing a reconstruction of this argument, we must first explicate two unclear concepts; the concept expressed by 'proof' and the concept expressed by 'UFO'. First consider 'proof'. We may clarify the explicandum as "supporting a conclusion with various steps, or information," and give as examples "Euclid's proof of the Pythagorean theorem," or "the proof that convicted Bruno Hauptman." Therefore, this is an explicandum, and we may proceed with explication. The explicandum is not well suited for the author's purpose here because given the explicandum it is not clear what sort of conclusion is to be established by a proof. However, he seems to claim that we may conclusively establish the truth of a conclusion by "proof" that is less dramatic than a landing at the River Entrance to the Pentagon. Therefore, we may propose, as an explicatum of 'proof', the concept expressed by 'evidence that is sufficient to conclusively establish the truth of a conclusion'.

Secondly, consider 'UFO'. We may clarify the explicandum as "an aerial phenomena that we cannot explain," or "a mysterious moving object that appears to be from outer space" and give as examples "the UFO later learned to be a large weather balloon" or the "UFO Calvin Parker believes he saw." Therefore, this is an explicandum, and we may proceed with explication. The explicandum is not well suited for the author's purpose here because given the explicandum, it is not clear what is at stake in providing proof that UFO's exist. Given the explicandum, it is unclear what he is seeking to prove. Therefore, we may propose, as an explicatum of UFO, the concept expressed by 'extra-terrestrial spacecraft piloted by intelligent extra-terrestrial astronauts'.

In providing these two explications on the author's behalf, we now see that in reconstructing his argument we must provide a valid deductive, rather than a strong inductive argument. This is because his claim, given the explicatum of 'proof', and the explicatum of 'UFO', is that he is providing evidence that conclusively establishes the truth of the conclusion that extraterrestrial spacecraft piloted by intelligent extraterrestrial astronauts exist. Clearly, an inductive argument will not do; an inductive argument establishes some degree of probability, not truth.

Given these explications, we may, therefore, propose to reconstruct the argument as follows:

7.2

1. If a ground radar operator detects a UFO, and a jet is sent to intercept it, and the jet's pilot sees the UFO, or fires at the UFO, and the UFO flys away at phenomenal speed, then this is proof that UFO's exist.
2. A ground radar operator detected a UFO, and a jet was sent to intercept it, and the jet's pilot saw the UFO, and the jet's pilot locked his radar on the UFO and fired at the UFO, and the UFO flew away at phenomonal speed.

∴ 3. This is proof that UFO's exist

Argument 7.2 is clearly a valid deductive argument. Its logical form may be captured as follows:

7.3

1. $[(P \,.\, Q \,.\, R \,.\, (S \vee T) \,.\, U) \supset V]$
2. $[P \,.\, Q \,.\, R \,.\, S \,.\, T \,.\, U]$

∴ 3. V

Conclusion 3 clearly follows from 1 and 2 by $\supset$E. However, 7.2 is only a proposed reconstruction of 7.1 We are not in a position to evaluate 7.2 as it stands; both premise 1 and premise 2 involve what we have called psychological contexts. Therefore, our reconstruction is not finished.

Consider premise 1 of 7.2. Intuitively, if a ground radar operator <u>knew</u> by observing his radar scope that he had detected a UFO, then one would not need to send up a jet to verify his observation. However, we can see that he detects what he <u>believes</u> to be a UFO, since it may be an enemy missile, a radar anomaly or a misplaced weather balloon. Similarly, the jet's pilot sees what he <u>believes</u> to be the UFO in question, since it may be some other phenomenon. (To see this, consider that it may be a different UFO.) Therefore, both premise 1 and premise 2 require the introduction of a psychological context.

7.2'

1. If a ground radar operator believes that he detected a UFO, and a jet is sent to intercept it, and the jet's pilot believes he sees the UFO, and the jet's pilot locks his radar on what he believes to be the UFO, or fires at what he believes to be the UFO, and what he believes to be the UFO flies away at phenomenal speed, then this is proof that UFO's exist.
2. A ground radar operator believed that he detected a UFO, and a jet was sent to intercept it, and the jet's pilot believed he saw the UFO, and the jet's pilot locked his radar on what he believed to be the UFO, and fired at what he believed to be the UFO, and what was believed to be the UFO flew away at phenomenal speed.

$\therefore$ 3. This is proof that UFO's exist.

The logical form of 7.2' may be captured as follows:

7.2'

1. [BP . Q . BR . (BS v BT) . BU] $\supset$ V
2. [BP . Q . BR . BS . BT . BU]

$\therefore$ 3. V

'B' is used to prefix statements containing 'believes'. We can see that 7.3' is also a valid deductive argument; 3

clearly follows from 1 and 2 by $\supset$ E. We can see that 7.2' is the clearest possible construal of 7.1 that is consistent with the author's expressed and implied views. Therefore, 7.2' is a reconstruction of 7.1. We are now in a position to evaluate 7.2'.

While 7.2' is a valid deductive argument, it is not a sound deductive argument. Premise 1 is clearly false. Given the explicatum of 'proof' and the explicatum of 'UFO', this can be seen even more clearly. If a radar operator and a jet pilot believe that they detected or saw an extraterrestrial spacecraft piloted by extraterrestrial astronauts, it does not follow that these beliefs conclusively established the truth of the statement 'UFO's exist'. To claim that it does is to invalidly conclude $(\exists x)(Px)$ from 'B $[(\exists x)(Px)]$', where 'B' is used to prefix statements containing 'believes'. We may conclude our evaluation of 7.2' by stating that the premises do not support the truth of the conclusion, and that, therefore, 7.2' is not a good argument. However, this is not to say that 7.2' is not a good reconstruction of 7.1; it is the clearest possible construal of the author's views; it just so happens that the author's views are mistaken.

Such reconstruction may also be provided in the form of inductive arguments. This may be done whenever conclusions are stated and we note that evidence is presented that the author claims supports these conclusions. Reconstruction of such arguments proceeds in a similar manner, except that we capture the logical form of an inductive, rather than a deductive argument, and appeal to all relevant available evidence. Reconstructions, therefore, can be seen to involve all the material we have considered so far.

Models

1. Provide an example of a reconstruction that involves providing an inductive argument. (Consider one from the reading.) Point out that providing conceptually significant criticism first involves reconstructing arguments such that they avoid obvious errors and are consistent with the author's expressed or implied views, and secondly, involves evaluating the reconstruction.

2. Provide several reconstructions, both deductive and inductive arguments, involving all the clarifications we have considered and explain how they are provided and evaluated.

3. Point out the importance of providing reconstructions. Consider the advancement of knowledge in science, the solution of philosophical problems, and the solution of crimes, etc. Consider, for example, the reconstruction of arguments about the assassination of J.F.K. Point out the advantage of knowing that certain conclusions are not supported by the evidence for providing alternative conclusions.

Exercises

1. Have the students carefully consider the conclusions Fuller draws about Arigo from the evidence he presents in his book, Arigo: Surgeon of the Rusty Knife. Then have them each provide a reconstruction of an argument on Fuller's behalf designed to establish one of these conclusions. Then ask them to show that it is indeed a reconstruction, according to the principle of

charity. Then ask them to evaluate the reconstruction to determine if the argument supports the conclusion.

2. Have the students carefully consider the conclusions the Blums draw about UFO's from the evidence they present in their book Beyond Earth: Man's Contact with UFO's. Then have them each provide a reconstruction of an argument in the Blums' behalf designed to establish one of these conclusions. Then ask them to show that it is indeed a reconstruction, according to the principle of charity. Then ask them to evaluate the reconstruction to determine if the argument supports the conclusion.

3. Have the students repeat the above procedures for the conclusions Von Dänigan draws about ancient astronauts from the evidence he presents in his book Chariots of the Gods, and for the conclusions Berlitz suggests about a mystery in the Bermuda Triange from the evidence he presents in his book The Bermuda Triangle. These reconstructions are very useful for instructional purposes when the students present them orally to the group.

Section Three

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Section Four: Providing Arguments

Subsection 1 - Providing Versus Reconstructing Arguments

We have seen, given certain reconstructions of arguments, that when we evaluate the reconstructions, some fail to support their conclusions, and we have considered ways that both inductive and deductive arguments can be shown to fail to support their conclusions. Now suppose we find that a given conclusion C is not supported by deductively sound, or inductively strong arguments. This may lead us to suppose that $\sim$ C may be supported by deductively sound, or indudictively strong arguments. Note that in pointing out that C is not supported by deductively sound or inductively strong arguments, we are not entitled to claim, simply on these grounds alone, that C is false. To make and support such a claim, we must give a deductively sound or an inductively strong argument with $\sim$ C as the conclusion. Giving such an argument to support any statement, whether or not the statement is the negation of a conclusion that we have shown not to be supported by arguments, we shall call providing an argument to support a given conclusion.

Providing an argument to support a given conclusion C involves, among other things, gathering our own information to form the premises to support the conclusion. Gathering this information may mean gathering evidence in providing inductively strong arguments, or may mean providing certain logical relationships among premises known to be true and the conclusion in providing deductively sound arguments. Clearly, in gathering such information, we are not limited by the principle of charity to select information consistent with a given author's expressed or implied views, since we are giving our own argument in an original form. We are the authors of the argument. Therefore, providing an argument is not the same as reconstructing an argument.

However, in the process of providing an argument we may employ the methods of reconstruction discussed above. For example, once we have proposed an argument, we must evaluate it, and perhaps engage in reconstructing our own argument, given that we find errors which do not provide the only support for the conclusion. Of course, we may find in our evaluation that the argument is not conceptually significant, and that, therefore, we must provide a different argument to support the conclusion. Providing an argument, therefore, also involves all the techniques we have considered for evaluating arguments.

Subsection 2 - Providing Deductive Arguments

Providing deductive support for a given statement S may be as simple as providing what we call the suppressed premise or premises of an enthymeme with the given statement S as the conclusion. This could be interpreted as the simplest form of the reconstruction of a given argument, but providing such suppressed premises is also useful in providing deductive support for a given statement. Consider the following example:

2.1

1. Stonehenge is older than the pyramids.
2. The pyramids are older than the Piri Reis Map.

∴ 3. Stonehenge is older than the Piri Reis Map.

Statement 2.1 is translated into our symbols, using 's' as a constant to stand for 'Stonehenge', 'p' as a constant to stand for 'pyramids' and 'r' as a constant to stand for 'the Piri Reis Map', and 'O' as the relation 'older than' as follows:

2.2

1. Osp
2. Opr

∴ 3. Osr

argument 2.1, as represented by 2.2, is obviously a valid argument. However, strictly speaking, given just premises 1 and 2, 3 does not follow deductively. Ordinarily, in presenting such an argument, one might present only these two premises and the conclusion on the grounds that everyone knows that 'being older than' is a transitive relation.

Relational arguments are very common ways of providing deductive support for given statements, and many of them depend on the relations we discussed earlier. But the relation itself is seldom, if ever, explicitly stated as a premise because it is generally assumed to be among the body of common knowledge presupposed in the context in which the argument appears. Such incompletely expressed arguments, with one or more of the premises implicitly understood, are called enthymemes.

We may supply the missing premise for 2.1 by simply stating that being 'older than' is a transitive relation as an additional premise. This can be captured in rewriting 2.2 as follows:

2.3

$$
\begin{array}{rl}
1. & Osp \\
2. & Opr \\
\underline{3.} & (\forall x)(\forall y)(\forall z)\ [Oxy\ .\ Oyz) \supset Oxz] \\
\therefore\ 4. & Osr
\end{array}
$$

We may now prove that, written as 2.3, 2.1 is a valid deductive argument. When such arguments are provided by others, we are obviously bound by the principle of charity to include such missing premises in a reconstruction of such arguments for conceptually significant evaluation. However, a consideration of enthymemes can more importantly provide some insight into the process of providing deductive support for particular statements.

The insight provided by this consideration of enthymemes is that we must often appeal to the body of common knowledge presupposed in a given context to provide premises to support a given conclusion. Consider the following example.

Suppose that we are attempting to provide deductive support for the statement "Pluto is further from the Earth than the Moon." By inspecting the relation 'is further from the Earth than', we can determine that this relation is transitive, asymmetrical and irreflexive. Consider the transitive property of the relation. We know that if Pluto is further from the Earth than Mars, and if Mars if further from the

Earth than the Moon, then it follows that Pluto is further from the Earth than the Moon, given transitivity. This can be seen in our symbols as follows, letting 'F' stand for the relation 'is further from the Earth than', and 'p' stand for 'Pluto', 'm' stand for the 'Moon', and 'a' stand for 'Mars'.

2.4

1. Fpm
2. Fma
3. $(\forall x)(\forall y)(\forall z)\ [(Fxy\ .\ Fxz) \supset Fxz]$

$\therefore$ 4. Fpa

Argument 2.4, therefore, appeals to the transitive nature of the relation and our common knowledge about the planets to provide deductive support for the given statement. We may do so by considering the other properties of the relation.

Consider the asymmetrical property of the relation. We know that Pluto and the Moon are not the same distance from the Earth. Given the asymmetrical property of 'is further from the Earth than', we know that it is not the case that Pluto is further from the Earth than the Moon and that the Moon is further from the Earth than Pluto, so either the Moon is further from the Earth than Pluto or Pluto is further from the Earth than the Moon. This leads us to see that our argument can begin with: if it is not the case that Pluto is further from the Earth than the Moon, then the Moon is further from the Earth than Pluto. Secondly, we know that it is not the case that the Moon is further from the Earth than Pluto. Therefore, Pluto is further from the Earth than the Moon. We are thus able to consider the asymmetrical property of this relation to produce simple deductive support for the given statement. This can be seen in our symbols as follows:

2.5

1. $\sim Fpm \supset Fmp$
2. $\sim Fmp$

$\therefore$ 3. $\sim\sim Fpm$

Argument 2.5, therefore, appeals to the asymmetrical nature of the relation and our common knowledge about the planets to provide deductive support for the given statement. (We may also consider the irreflexivity of the relation.)

From the consideration of these simple properties of relations, we may provide deductive support for statements involving relations. However, enthymemes do not only involve relations. For example, consider the following argument:

2.6

1. Any ocean-dwelling mammal can outswim any land-dwelling mammal.
2. Some humans can outswim any cat.

:. 3. Any dolphin can outswim any cat.

There are several unstated premises in 2.6 which we must provide to prove that 2.6 is a valid argument. Obviously a premise stating the transitivity of 'can outswim' must be stated, but also the following non-relational premises must be stated:

a) All humans are land-dwelling mammals.

b) All dolphins are ocean-dwelling mammals.

These non-relational premises are also assumed to be among the body of common knowledge. We may, therefore, capture the logical form of 2.6, letting 'O' stand for 'ocean-dwelling mammal', 'L' for 'land-dwelling mammal', 'S' for 'can outswim', 'H' for 'human', 'C' for 'cat', and 'D' for 'dolphin' as follows:

2.7

1. $(\forall x)(\forall y)\ [(Ox\ .\ Ly) \supset Sxy]$
2. $(\forall x)(Hx \supset Lx)$
3. $(\ \ z)(Hz\ .\ [(\ \ w)(Cw \supset Szw))]$
4. $(\forall x)(\forall y)(\forall z)\ [(Sxy\ .\ Syz) \supset Sxz]$
5. $(\forall x)(Dx \supset Ox)$

:. 6. $(\forall x)(\forall y)\ [(Dx\ .\ Cy) \supset Sxy]$

Consider the following example, again appealing to the body of common knowledge presupposed in a given context to provide deductive support for a given statement. Suppose that we are attempting to provide deductive support for the statement 'it is not the case that Arigo prevents germ-caused infections in unclean wounds without using antiseptics or other sterilization'.

We may begin our attempt to provide deductive support for this statement by considering what we know to be true about killing germs, about infections, and about antiseptics. First, we know that only killing germs prevents germ-caused infections and that only antiseptic or other sterilization can kill germs. Given this knowledge, we might proceed as follows. Since we want the conclusion of the argument to be of the form $\sim \emptyset$, where $\emptyset$ is the proposition expressed by the statement 'Arigo prevents germ caused infections without using germ-killing antiseptics or other sterilization', we might assume $\emptyset$, and then attempt to present an argument which derives a contradiction from assuming $\emptyset$. This, of course, allows us to conclude $\sim \emptyset$. Such an argument, therefore, if valid and sound, will deductively support $\sim \emptyset$. Consider formulating the following argument:

2.8

1. Only killing germs prevents germ-caused infections in unclean wounds.
2. Only antiseptic or other sterilization can kill germs.
3. Only antiseptic or other sterilization can prevent germ-caused infection in unclean wounds.
4. Arigo does prevent germ caused infections in unclean wounds without germ-killing antiseptics or other sterilization.
5. It is not the case that only antiseptic or other sterilization can prevent germ-caused infections in unclean wounds.
6. Only antiseptic or other sterilization can prevent germ-caused infections in unclean wounds. [Contradiction]

∴ 7. It is not the case that Arigo prevents germ caused infections in unclean wounds without antiseptics or other sterilization.

Premise 1 and Premise 2 are given knowlege about germs, infections and antiseptics. Premise 3 follows from 1 and 2, as we shall see shortly. So the strategy is to assume the negation of the conclusion that we want to prove as we do in premise 4 and given this assumption, to derive a contradiction as we do in deriving 5, which contradicts 2. This allows us to conclude that the given assumption 4 is false. This, of course, is logically equivalent to concluding that the negation of the assumption is true, which we do in 7. However, given this intuitive view of the argument provided deductively to support the given statement, we must clarify the argument, translate it into LPC, and prove that it is valid.

Consider the translation of 2.8 into LPC. As we can see, the English wording is slightly difficult to translate easily into LPC. For this reason, we must consider the proposition expressed by each statement and express the proposition in clearer English statements which we may then easily translate into LPC. In this case, it is helpful to think of the quantifiers as ranging over persons. We may, therefore, translate 2.8 into logically equivalent English statements and also into LPC as follows:

2.9

1. Anyone who prevents germ-caused infections in unclean wounds kills germs. (Let 'Px' stand for 'x prevents germ-caused infections in unclean wounds' and 'Gx' stand for 'x kills germs')
   $(\forall x)(Px \supset (Gx)$ Given Assumption
2. Anyone who kills germs uses antiseptic or other sterilization. (Let 'Ux' stand for 'x uses antiseptic or other sterilization')
   $(\forall x)(Gx \supset Ux)$ Given Assumption
3. Anyone who prevents germ-caused infection in unclean wounds uses antiseptic or other sterilization.
   $(\forall x)(Px \supset Ux)$ 1, 2
4. Arigo succeeds in preventing germ-caused infections in unclean wounds and yet does not use antiseptic or other sterilization. (Let 'a' stand for 'Arigo')
   $Pa \,.\, \sim Ua$ A
5. It is false that anyone who prevents germ-caused infections in unclean wounds uses antiseptic or other sterilization.
   $\sim (\forall x)(Px \supset Ux)$ 4
6. But anyone who prevents germ-caused infections in unclean wounds uses antiseptic or other sterilization.
   $(\forall x)(Px \supset Ux)$ 3, Reit.

:. 7. It is false that Arigo succeeds in preventing germ-caused infections in unclean wounds and yet

does not use antiseptic or other sterilization.
$\sim$ (Pa . $\sim$ Ua)   5, 6

We must now prove that 2.9 is a deductively valid argument. This is quite easy to do, given our proof procedure:

2.10

	1.	$(\forall x)(Px \supset Gx)$	Given Assumption
	2.	$(\forall x)(Gx \supset Ux)$	Given Assumption
b	3.	Pb	A
	4.	$Pb \supset Gb$	1, UQE
	5.	Gb	3, 4, $\supset$E
	6.	$Gb \supset Ub$	2, UQE
	7.	Ub	5, 6, $\supset$E
	8.	$Pb \supset Ub$	7, $\supset$I
	9.	$(\forall x)(Px \supset Ux)$	8, UQI
	10.	$Pa \cdot \sim Ua$	A
	11.	$\sim (\forall x)(Px \supset Ux)$	10, DM
	12.	$(\forall x)(Px \supset Ux)$	9, Reit.
	13.	$\sim (Pa \cdot \sim Ua)$	11, 12, $\sim$ I

The conclusion, of course, is logically equivalent to Pa $\supset$ Ua, or in English, if Arigo prevents germ-caused infections, then he uses antiseptic or other sterilization. The argument is deductively valid, we must now evaluate the argument's soundness.

Clearly 2.9 is a sound argument. According to our proof of its validity, 2.10, the conclusion depends only on the given premises 1 and 2. If these are true, then the argument is sound. Clearly 1 and 2 are true; there are no obvious counterexamples to either 1 or 2. Therefore, 2.9 is a sound argument.

Therefore, we can see that we have indeed provided deductive support for the given statement in providing this sound deductive argument. To do so, we simply appealed to relevant common knowledge, much like we do when we supply the implicit premises in an enthymeme. We then formulate the argument, perhaps reformulate it, then translate it into our symbols, prove that it is valid, and then evaluate its soundness.

Models

1. Since this is the most difficult material so far, present many statements and provide deductive support for them in class, as a group. Point out how and why, for example, you avoid the word 'can' or relations that are not specifically related to objects in a specified domain. (You might consider introducing Modal Logic rigorously at this point, since there will be many English statements for which we cannot provide deductive support without Modal Logic.)

2. Attempt to provide deductive support for a given statement that, in fact, fails to support the statement, because the statement is false. Show that while the argument is valid, at least one premise must be false if the conclusion is false.

Exercises

1. Have the students prove that 2.3, 2.4, 2.5, and 2.7 are valid.

2. Have the students provide deductive support for the statement 'Pluto is further from the Earth than the Moon' by considering irreflexivity.

3. Have the students provide deductive support for the following statements:

   a) 'The pyramids were not built by men from outer space.'
   b) 'Arigo does not stop the flow of blood from deep wounds with verbal commands.'

4. Have them present their arguments and then evaluate them as a group, reconstructing them when necessary.

<u>Subsection 3 - Providing Inductive Arguments</u>

From our study of inductive logic, we can see that providing inductive arguments to support a given statement S may involve providing statements of evidence E for S such that the statements composing E are all true or have high probability, and such that $P\ (S/E\ .\ K) > P\ (\sim S/E\ .\ K)$. Or, if S is a statement about the relation of a conditioning property to a conditioned property, then providing inductive support for S involves providing possible conditioning properties and supporting the relation of the conditioning property to the conditioned property stated in S. This relation, as we have seen, will be that the conditioning property is either a necessary, a sufficient, or a necessary and sufficient condition for the conditioned property. This, of course, involves applying what we have called inductive elimination.

Subsection 3A - Statements of Evidence

We shall first consider providing statements of evidence for a given statement. To provide such an inductive argument, we may, like in providing deductive support for a given statement, appeal to relevant common knowledge. However, we are more likely to function as "detectives," and appeal to investigations and research. Of course, in doing such investigations and conducting such research, we must remain open to the possiblity that we may fail to support the given statement, and, perhaps, support its negation. Obviously, we must follow the facts where they lead us rather than fit the facts to our desired end.

Consider providing inductive support for the statement 'the crew of the Mary Celeste abandoned ship and were lost at sea'. The first step, of course, is to function like a detective and to research the disappearance of the Mary Celeste's crew.[152] Our research shows that the Mary Celeste was a 103-foot brigantine found abandoned at sea by the Dei Gratia on December 4, 1872. The crew of the Dei Gratia received a small salvage fee. The Mary Celeste left New York

[152] The following account is from Lawrence David Kusche, The Bermuda Triangle Mystery: Solved, New York, Warner Books, 1975.

in early November, 1872, bound for Genoa, Italy. When she was found, Captain Griggs, his wife, daughter and crew of eight were gone; the ship was completely deserted. The lifeboat was gone; launched but not ripped away by accident. The ship carried 1,700 barrels of alcohol, which was intact. However, there was 3-1/2 feet of water in the hold. The ship's papers, except the Captain's log, were missing along with the navigation instruments. When found, the Mary Celeste's sails were set, but some were torn. The forehatch was found ripped open, and a line was trailing the ship, but there was no serious damage.

Given this basic information and all relevant available evidence, we shall initiate our investigation by formulating what we shall call hypotheses. An hypothesis, for our purpose here, is simply a suggestive and physically possible explanation, which given what we already know, allows us to gather other specific relevant facts to guide our investigation and our attempt to formulate probabilities based on these facts. For example, consider as an hypothesis that the crew mutinied, killed the captain and his family, and delivered the ship to the captain of the Dei Gratia for the salvage fee. Proposing this hypothesis warrants our investigating the size of the salvage fee, the financial interests of the crew members, the character of the captain, the financial interests of the owners, the character of the crews of both ships and the financial interests and character of the captain of the Dei Gratia.

Suppose that our investigation reveals that the salvage fee was very small, that the crew members had little to gain financially, that the Captain was well liked, that the owners had nothing to gain by insurance claims and that the Captain of the Dei Gratia was friendly with the Captain of the Mary Celeste, well liked and had no potential for financial gain given the situation, and that the crew members of the Mary Celeste were never seen again. This information shows that the hypothesis is not highly probable; it is not evidence for this hypothesis. If we formulate an inductive argument with the hypothesis as the conclusion and this information as premises, the resulting argument will be judged to be weak. However, note that proposing this hypothesis has been far from worthless; we have discovered evidence that rules out conclusions that may be incompatible with the statement 'the crew members of the Mary Celeste abandoned ship and were lost at sea'. For example, proposing and evaluating this hypothesis rules out the statement 'the crew members of the Mary Celeste jumped ship for the salvage money' or the statement 'the crew members of the Mary Celeste sailed home on the Dei Gratia.'

We formulated this hypothesis to gather information to discover evidence to support the statement 'the crew members of the Mary Celeste abandoned ship and were lost at sea'. Once we discover relevant evidence, we shall put it in the form of an inductive argument, test its inductive strength, and then determine the probability of the conclusion. Since we have ruled out that the crew jumped ship for financial gain, and that the crew sailed home on the Dei Gratia, we must consider proposing another hypothesis to discover further evidence. For example, consider as an hypothesis that some natural disaster with bad weather caused the crew to abandon ship. Proposing this hypothesis warrants our investigating the weather patterns in the area where the Mary Celeste was found, and the physical evidence of any such natural disaster aboard ship. It also warrants our investigating the standard procedures the crew followed in the event of such natural disasters aboard ship, or experience with bad weather.

We already know that we may rule out an actual fire since the only damage found was the torn sails and the ripped-open forehatch. We might suppose that the sails were torn because the ship sailed without a crew for some time in bad weather. We know that the ship carried 1,700 barrels of alcohol, and we know that alcohol is extremely volatile, that is, it gives off fumes. We also know that the Mary Celeste was a wooden ship, illuminated by kerosene lamps. Therefore, we might suppose that alcohol fumes from a poorly vented hold illuminated by kerosene lamps blew open the forehatch. Vapor resembling smoke would then billow out of the forehatch. Fearing a fire, the Captain and crew may then have simply followed the standard procedure in the event of a fire on a ship with a flammable cargo. We discover, upon investigation, that this standard procedure is to abandon ship; to remove the ship's papers, the navigation equipment, attach a line to the ship, launch the lifeboat and secure the line from the ship to the lifeboat containing the crew. That this occurred is supported by the discovery that the ship's papers, navigation instruments, and lifeboat were missing, and that a line was trailing the ship. We also discover, upon investigation, that this area of the Atlantic is noted for its sudden, violent storms, which may account for the separation of the line trailing the Mary Celeste from the lifeboat containing the crew. Further evidence that there was bad weather is that the hold had 3-1/2 feet of water in it, which, in the absence of structural damage, had to come from the open forehatch, and that the sails were torn.

Therefore, we can see that by formulating and evaluating such hypotheses in an attempt to gather and evaluate evidence, we may discover evidence for constructing inductively strong arguments to provide inductive support for the statement 'the crew members of the Mary Celeste abandoned ship and were lost at sea'.

However, we may also see that given our detective work, providing such inductive support for this statement involves providing more than one simple inductive argument. Intuitively, we can see that we must, in this case, provide inductive arguments inductively to support conclusions, in turn, to be used as premises in our argument inductively to support the statement. While it is desirable to use premises known to be true in providing inductive support for given statements, often the best we can do is to use premises that have high probability. This is why our appeal to all relevant available evidence is not restricted to knowledge.

We must first establish that they had some reason to abandon ship, consistent with the physical evidence, and secondly, establish that there is some reason that they were lost at sea consistent with the physical evidence. To do so is to provide inductive support for the statement 'the crew members of the Mary Celeste abandoned ship and were lost at sea'. Given our detective work and the evidence gained by forming the hypotheses, consider the following argument:

3.1

1. When found abandoned, the _Mary Celeste_ was structurally sound except the forehatch to the hold was blown off.
2. She carried 1,700 barrels of alcohol in the hold.
3. Alcohol gives off fumes, which, when ignited, explode and produce vapor resembling smoke.
4. The hold was poorly vented and illuminated by kerosene lamps.

∴ 5. Alcohol fumes ignited and blew open the forehatch producing vapor resembling smoke.

Given 5 of 3.1, we must now attmept to establish that they abandoned ship. Consider the following argument, given 3.1:

3.2

1. The _Mary Celeste's_ lifeboat was gone and a line trailed the ship when she was found abandoned at sea.
2. The lifeboat held 12 people and the _Mary Celeste_ carried 11 people: the Captain, his wife, his daughter, and a crew of eight.
3. The ship's papers, the navigation equipment and the crew were gone when she was found abandoned at sea.
4. Standard procedure in the event of a suspected fire on a wooden ship containing flammable material was to launch the lifeboat containing the ship's papers and navigation equipment and crew, and attach a line to the ship and to the lifeboat saving the crew in the event the ship exploded.
5. (5 from 3.1) Alcohol fumes ignited and blew open the forehatch producing vapor resembling smoke.

∴ 6. The crew of the _Mary Celeste_ abandoned ship in the lifeboat secured to the Mary Celeste by a trailing line.

Given 3.1 and 3.2, we must now attempt to establish that they were lost at sea. Consider the following argument:

3.3

1. The Mary Celeste had 3-1/2 feet of water in the hold, some sails were torn, and a line trailed the ship when she was found abandoned at sea.
2. The area of the Atlantic where she was found and through which she sailed is noted for its sudden, violent storms and heavy seas.
3. Lifeboats are structurally weak and unable to withstand heavy seas, especially when fully loaded.
4. Lifeboats are easily separated from lines securing them during heavy seas.
5. Abandoned ships under full sail in violent storms and heavy seas take water through open hatches, tear sails, and pull hard on trailing lines securing launched, loaded lifeboats.
6. Abandoned ships under full sail in violent storms and heavy seas sail randomly, quickly changing direction.
7. (6 from 3.2) The crew of the Mary Celeste abandoned ship in a lifeboat secured to the Mary Celeste by a trailing line.

∴ 8. The crew of the Mary Celeste were lost at sea.

Combining 3.1, 3.2, 3.3, therefore, we have provided inductive support for the given statement. We must now, in turn, evaluate 3.1, 3.2, and 3.3 to determine that they are inductively strong and that their conclusions are highly probable. This will allow us to determine whether or not P (S/E . K) > P (∿ S/E . K) where 'S' is 'the crew was lost at sea and 'E' stands for all the evidence we have provided through our detective work to inductively support 'S'.

Consider 3.1. Again, let the numbers of the premises and conclusion be propositional constants. The premises of 3.1 are evidence for the conclusion provided that P (5/1 . 2 .

$3 . 4) > P (\sim 5/1 . 2 . 3 . 4)$. Consider 1. Even if true, 1 alone is not evidence for 5. Intuitively, $P (5/1)$ $P (\sim 5/1)$. However, when 1 is conjoined with 2, 3 and 4, we we can see that 5 is the best explanation, given these premises. Intuitively, $P (5/1 . 2 . 3 . 4) > P (\sim 5/1 . 2 . 3 . 4)$. Therefore, the premises of 3.1 provide evidence for the conclusion, and 3.1 is a strong inductive argument.

We must now consider the probability of the conclusion. Since the premises of 3.1 are all true and they are not detached, $P (1 . 2 . 3 . 4) > P (\sim (1 . 2 . 3 . 4))$. Since this is the case, $P (5/1 . 2 . 3 . 4 . K) > P (\sim 5/1 . 2 . 3 . 4 . K)$. Therefore, $P (5) > P (\sim 5)$, and 3.1 is a good inductive argument that inductively supports its conclusion.

Consider 3.2. The premises of 3.2 are evidence for the conclusion provided that $P (6/1 . 2 . 3 . 4 . 5) > P (\sim 6/1 . 2 . 3 . 4 . 5)$. Consider 1. If true, 1 is evidence for 6; there may, of course, be other explanations for 1, but 6 intuitively seems to be the best explanation so we can see that $P (6/1) > P (\sim 6/1)$. Consider 2. Even if true, 2 alone does not seem to be evidence for 6, $P (6/2)$ $P (\sim 6/2)$. However, when conjoined with 3, 4 and 5, 23 can intuitively see that the conjunction is evidence for 6; $P (6/1 . 2 . 3 . 4 . 5) > P (\sim 6/1. 2 . 3 . 4 . 5)$.

Therefore, the premises of 3.2 provide evidence for the conclusion, and 3.2 is a strong inductive argument.

We must now consider the probability of the conclusion. Premises 1, 2, 3 and 4 of 3.2 are all true. Premise 5 of 3.2 is the conclusion of 3.1, which we have shown to be more probable than its denial. Since these premises are not detached, $P(1 . 2 . 3 . 4 . 5 . K) > P(\sim(1 . 2 . 3 . 4 . 5 . K)$. Since this is the case, $P(6/1 . 2 . 3 . 4 . 5 . K) > P(\sim 6/1 . 2 . 3 . 4 . 5 . K)$. Therefore, $P(6) > P(\sim 6)$, and given 3.1, 3.2 is a good inductive argument that inductively supports its conclusion.

Consider 3.3. The premises of 3.3 are evidence for the conclusion provided that $P(8/1 . 2 . 3 . 4 . 5 . 6 . 7) > P(\sim 8/1 . 2 . 3 . 4 . 5 . 6 . 7)$. Consider 1. Even if true, 1 alone is not evidence for 8; $P(8/1) \leq P(\sim 8/1)$. However, when conjoined with 2, 3, 4, 5, 6 and 7, we can intuitively see that the conjunction is evidence for 8; $P(8/1 . 2 . 3 . 4 . 5 . 6 . 7) > P(\sim 8/1 . 2 . 3 . 4 . 5 . 6 . 7)$. Therefore, the premises of 3.3 provide evidence for the conclusion, and 3.3 is a strong inductive argument.

We must now consider the probability of the conclusion. Premises 1, 2, 3, 4, 5 and 6 of 3.3 are all true.

Premise 7 of 3.3 is the conclusion of 3.2, which we have shown to be more probable than its denial. Since these premises are not detached, P (1 . 2 . 3 . 4 . 5 . 6 . 7 . K) > P(∿ (1 . 2 . 3 . 4 . 5 . 6 . 7 . K). Since this is the case, P (8/1 . 2 . 3 . 4 . 5 . 6 . 7 . K) > P (∿ 8/1 . 2 . 3 . 4 . 5 . 6 . 7 . K). Therefore, P (8) > P (∿ 8), and given 3.1 and 3.2, 3.3 is a good inductive argument that inductively supports its conclusion.

Given 3.1, 3.2 and 3.3, and our evaluation of them we can see that the probability of 'the crew of the Mary Celeste abandoned ship and were lost at sea', given the evidence we have gathered to provide inductive arguments to support the statement, is greater than the probability of the statement without such inductive support. Therefore, we have successfully provided inductive arguments to support the statement 'the crew of the Mary Celeste abandoned ship and was lost at sea'.

Subsection 3B- Inductive Elimination

We shall now consider providing inductive support for a given statement S by applying inductive elimination. Note that we may apply inductive elimination only to statements about the relation of a conditioning property to a conditioned property. Providing inductive support for such a statement

S by applying inductive elimination, then, involves providing possible conditioning properties and supporting the relation of the conditioning property to the conditioned property stated in S.

Consider providing inductive support for the statement 'the epileptic convulsions of a 9-year old American boy treated by Arigo subsided because of the doses of the drugs Phenobarbital and Dilantin, given by the boy's physician, and not because of Arigo's treatments'. Let S be a propositional constant standing for this statement. S makes a claim about a particular sufficient condition for a specific case. The claim is that the conditioning property, namely the dose of the drugs Phenobarbital and Dilantin given by the boy's physician is the sufficient condition for the conditioned property, namely the absence of epileptic convulsions in this particular 9-year old boy. Let J stand for the conditioned property and let H stand for this conditioning property. Clearly providing inductive support for S involves an application of what we have called the method of difference. Recall that in practice the actual method is the same as the inverse method of agreement; a property that is present when the conditioned property is absent cannot be a sufficient condition for the conditioned property. First, let us clearly specify this case as described by Fuller.

According to Fuller, the 9-year old American boy treated by Arigo had Jacksonian Epilepsy. He had been treated by his physician with Phenobarbital and Dilantin. (This we know to be a normal treatment for epilepsy.) The boy's mother brought him to see Arigo who prescribed eight different drugs (none of these drugs are identifiable in any drug index). Two months later, the boy went to summer camp. A year later, the boy was free of epileptic convulsions. Fuller, of course, concludes that the conditoned property S was caused by Arigo's treatments. Let I stand for the conditioned property of Arigo's treatment. Fuller's claim then, is that in this case, I is the sufficient condition for J. The statement we are attempting to support is that in this case, H is the sufficient condition for J.

Note that in providing inductive support for S, we must consider complex conditioning properties as well, besides the simple conditioning properties H and I. For example, the conjunctive property (H . I). We might also consider the complex properties of the absence of certain properties such as the property of the absence of an inferiority complex, since through research we discover that an inferiority complex may contribute to epileptic convulsions. Let G stand for the property of having an inferiority complex. Of course, $\sim$ G, then, is the complex property of the absence of an inferiority complex. Given $\sim G$, H, I, and (H . I) as possible conditioning properties, and J as the conditioned property in the actual occurrence, the actual occurrence one year after the events described can be represented as follows:

	Narrowed Down Possible Conditioning Properties				Conditioned Property
	$\sim G$	H	I	(H . I)	J
Actual occurrence one year later	P	P	P	P	P

We must now apply the method of difference by constructing test occurrences to determine the particular sufficient conditions in operation here. In the inverse method of agreement, these test occurrences simply involve empirically providing the properties in various combinations and determining which is sufficient for J by ruling out properties which are present when J is absent. In this case, however, applying the method of difference, we must provide test occurrences from research of the specific case at hand since we are looking for a particular sufficient condition. In this case, then, we may also rule out conditioning properties which are absent when J is present, because while they may be sufficient conditions for J, they are not the sufficient conditions of interest in this specific case.

Suppose that our research in this case first reveals that the boy, in fact, had an inferiority complex until he was free from epileptic convulsions. This allows us to rule out $\sim G$. Secondly, we learn that Dilantin takes a long period of time to have any effect, and that the 8 "drugs" prescribed by Arigo cannot be identified in any drug index and are, in fact, fictional names for harmless substances that are completely excreted by the body in the urine shortly after they are taken. This allows us to rule out I, and thereby rule out (H . I). The results of this research are as follows:

	Narrowed Down Possible Conditioning Properties				Conditioned Property
	$\sim G$	H	I	(H . I)	J
actual occurrence	P	P	P	P	P
Test-Research 1	A	P	P	P	P
Test-Research 2	A	P	A	A	P

Simply applying the method of difference to the results of this research summarized above allows us to conclude that H is the sufficient condition for J. This, in turn, supports S by supporting the relation of the conditioning property to the conditoned property stated in S. In this way, then, inducitve elimination can be used to provide inductive support for statements about the relation of a conditioning property to a conditioned property.

Models

1. This is a good opportunity to introduce students to research techniques and the use of the library. Point out the crucial role of research in providing inductive support for a statement. This is a good opportunity to review both inductive probability and inductive elimination in conjunction with a discussion of the importance of research.

2. Present many statements and provide inductive support for them in class as a group by providing statements of evidence and inductive arguments. Appeal to research already done earlier. For example, research done on Von Dänigan's claims, or research done on Blum's or Berlitz' claims.

3. Present many statements of a relation between a conditioning property and a conditioned property and provide inductive support for them in class as a group by applying inductive elimination. Be sure to apply the direct method of agreement, the inverse method of agreement, the method of difference, the double method of agreement and the joint method of agreement and difference. Again, point out the importance of test procedures as well as research.

4. Provide inductive support for a given statement that, in fact, fails inductively to support the given statement because research shows that the evidence is against the statement. Use statements that involve providing inductive arguments involving probability, and use statements that involve applying inductive elimination.

Exercises

1. Have the students provide inductive evidential support for the following statements: (Note: this involves specific research)

a) Arigo did not cure Belk's back condition (research such back conditions).

b) Arigo did not cure the American women's migraine-like headaches (research such migraine-like headaches).

c) Arigo did not cure acute leukemia in the 6-year old girl (research acute leukemia in children).

d) The UFO that seemed to follow a police officer, change colors from red to yellow to white, and hover in the sky to the west over his house all night was the planet Venus (research appearances of Venus when it is close to the Earth).

e) The UFO's reported to "take off very quickly" from specific points are not extraterrestrial spacecrafts (research the laws of physics; thrust, properties of chemical rockets, nuclear rockets, etc., and what was found at these specific points).

2. Have the students provide inductive elimination support for the following statements: (Note: this may involve research and test procedures).

   a) Leukemia is not cured by Potassium Chloride (KCL) (research medicinal effects of Potassium Chloride).

   b) Back pain is not eliminated only by Vitamin B12 (research medicinal effects of Vitamin B12).

   c) Faith in the healer is not a necessary condition for being healed (research to provide test procedures).

   d) Appearing to be an aerial phenomenon for which we have no specific, certain explanation is a necessary and a sufficient condition for being a UFO.

3. Have the students present their arguments and then evaluate them as a group, reconstructing them when necessary.

Section Four

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Section Five: Informal Fallacies in Arguments

Subsection 1 - The Goal of Arguments: Persuasion Versus Truth or High Probability

Thus far, we have considered the evaluation, reconstruction and provision of arguments designed to support a particular conclusion. Such arguments are usually presented to establish the truth or the high probability of a particular conclusion: the goal of these arguments is rationally to support a particular conclusion. When such deductive arguments are evaluated and found to be deductively valid and sound, we know that the conclusion is true. When such inductive arguments are evaluated and found to be inductively strong and to have a highly probable conclusion, we know that the conclusion is more likely true than false. In either case, we know that the argument in question rationally supports the conclusion. If we know how to evaluate such arguments correctly, and we find by evaluation that a deductive argument is valid and sound, or that an inductive argument is inductively strong and has a highly probable conclusion, then we are rationally persuaded to accept the conclusion. In this way, then, such arguments may be said to persuade us to accept the conclusion.

However, given such valid and sound deductive arguments, or such inductively strong inductive arguments, there may, in fact, be unreasonable people who refuse to accept the conclusion; people who are not, in fact, rationally persuaded to accept the rationally supported conclusion. This, of course, should not trouble us, since our interest in arguments is to establish the truth or the probability of the conclusion, and not simply to influence people's beliefs. A valid, sound deductive argument has a true conclusion whether or not anyone believes that the conclusion is true. Truth, as we have seen, is independent of people's beliefs. For example, to determine the truth value of the statement 'the Earth moves around the Sun', Nicholas Copernicus did not formulate a questionnaire asking people if they believed that it was true or false, and then assign the most popularly believed truth value to be the proposition expressed by the statement. In fact, at that time most all people believed that the statement was false.

Perhaps after our evaluation of Voliva's arguments, Voliva may still believe that it is not the case that the Earth is travelling at 600,000 miles per hour as astronomers claim, and believe that the Earth is not a sphere but is flat. This fact should not trouble us, since the matter has been rationally resolved by research and by argument. There is no need to conduct further research or to provide or reconstruct other arguments to support the above conclusions since we know that the above conclusions are false. Voliva's irrational belief in the truth of these conclusions is not of any importance to the rational resolution of the question. We may simply dismiss his failure to be rationally persuaded by the research and arguments as his own shortcoming and not a shortcoming of the research or arguments.

Sometimes, however, the goal of arguments used by people in various situations is not rationally to support a particular conclusion. Often the goal of an argument is simply to persuade opponents or an audience to accept a conclusion. In many such situations, valid and sound deductive arguments, or inductive arguments that are inductively strong with a high inductive probability are used rationally to persuade an opponent or an audience to accept a conclusion. However, sometimes arguments are designed simply to persuade opponents or an audience to accept a conclusion, yet fail rationally to support the conclusion. Such arguments are said to be psychologically persuasive, yet are neither valid nor sound deductive, nor strong inductive arguments with highly probable conclusions. The psychological persuasiveness of such arguments comes from errors in reasoning that are psychologically persuasive. We shall call such errors in reasoning that are psychologically persuasive fallacies. Arguments containing fallacies we shall call fallacious arguments. Recognizing such psychologically persuasive fallacious arguments and exposing the psychologically persuasive error in reasoning is sufficient to evaluate the argument and to show that it fails rationally to support its conclusion and is, therefore, of no cognitive significance.

We may understand a psychologically persuasive reason in a very broad and general sense for our purposes here. Clearly the notion must be broad enough to capture rationally persuasive valid and sound deductive arguments and rationally persuasive strong inductive arguments with highly probably conclusions, as well as persuasive errors in reasoning. Therefore, we may simply say that r is a psychologically persuasive reason for conclusion c if and only if there is some person x who is persuaded by r to accept c. This obviously includes many kinds of reasons. However, our interest in psychologically persuasive reasons in this section is limited to what we have called fallacies.

The interesting and important feature of fallacies is that they are errors in reasoning that are also psychologically persuasive. For this reason, it is important to distinguish what we have called rationally persuasive deductive and inductive arguments from fallacious arguments which may be psychologically persuasive even though they fail rationally to support their conclusions. Our interest, of course, is to insure that conclusions are rationally justified and that we are able rationally to justify our acceptance of a particular conclusion. Fallacies simply attempt to persuade without justifications.

Models

1. Discuss and give examples of arguments designed simply to persuade opponents to accept a conclusion, without rationally supporting the conclusion. You might consider advertising as a common example. Suggest that we might, given persuasion as the only goal, evaluate the success or failure of such arguments by counting the number of people who were persuaded by them. Point out how this differs from the evaluation of arguments that we have considered.

2. Discuss rational resolution and the role of people's beliefs in the evaluation of arguments. Point out that universal agreement is not common even though a particular question has been rationally resolved. Underline the fact that universal agreement has no bearing on the evaluation of arguments.

Exercises

1. Have the students find examples of arguments presented by scientists which rationally resolved a particular question, even though the majority of people refused to believe the conclusion. Have them consider Copernicus, Kepler, Harvey, Semmelweis, Pasteur, and other figures from the history of science. Ask them to draw parallels to other disciplines as well.

2. Have the students find examples of arguments designed simply to persuade us to accept a conclusion and not rationally to support the conclusion. Consider arguments in collective bargaining. Are such arguments designed simply to persuade us to accept a conclusion and not rationally to support the conclusion?

Subsection 2 - Formal Fallacies

Fallacies may be divided into three groups: formal fallacies, fallacies of ambiguity, and fallacies of relevance. We shall first consider formal fallacies. Formal fallacies involve violation of PC or LPC rules. Intuitively, we can see that not all violations of PC or LPC rules may be psychologically persuasive. For example, often blatant contradictions are psychologically persuasive even though they are a violation of PC and LPC rules. However, recall that our account of psychologically persuasive reasons is broad enough to include such blatant contradictions if one person is persuaded by the contradiction to accept an invalidly reached conclusion. Again, our interest in exposing these fallacies is to show that one has no reason to be persuaded; that the argument employing the fallacy does not support the conclusion. Often contradictions buried in a complex argument are not blatant, and may more clearly be psychologically persuasive. In either case, it is sufficient for our purposes here to say that a formal fallacy is any psychologically persuasive violation of PC or LPC rules. Some such psychologically persuasive violations of PC and LPC rules are common enough in arguments to be given specific names. One such formal fallacy is called denying the antecedent, and involves an error of the following form:

2.1

$$\begin{array}{rl} 1. & \Delta \supset O \\ \underline{2.} & \sim \Delta \\ \therefore\ 3. & \sim O \end{array}$$

1. If we unionize, then our troubles are over.
2. It is not the case that we unionize.

∴ 3. It is not the case that our troubles are over.

From our study of logic and our discussion of necessary and sufficient conditions in inductive elimination, we know that the absence of one particular conditioning property sufficient for a particular conditioned property does not guarantee the absence of the conditioned property; there may be another conditioning property present that is sufficient for the conditioned property. For statements, we may prove that 2.1 is invalid by using the truth table method.

Δ	O	$[((\Delta \supset O) \cdot \sim \Delta) \cdot \sim\sim O]$
t	t	t · f · t = f
f	t	t · t · t = t
t	f	f · f · f = f
f	f	t · t · f = f

Recall that one case (here, the case where Δ is false and 0 is true) in which the conjunction is true is sufficient to show that it is not a contradiction, since a contradiction is never true. Therefore, this argument form is invalid.

Another such formal fallacy is called affirming the consequent, and involves an error of the following form:

2.2

1. $\Delta \supset 0$
2. 0

$\therefore$ 3. Δ

1. If Oswald shot JFK in the head, then JFK is assassinated.
2. JFK is assassinated

$\therefore$ 3. Oswald shot JFK in the head

From our study of logic and our discussion of necessary and sufficient conditons in inductive elimination, we know that the presence of some conditioned property does not guarantee the presence of any one particular conditioning property sufficient for the conditioned property. For statements, we may prove that 2.2 is invalid by using the truth table method.

Δ	0	$[((\Delta \supset 0)\ .\ 0)\ .\ \sim\Delta]$
t	t	t . t . f = f
f	t	t . t . t = t
t	f	f . f . f = f
f	f	t . f . t = f

Again, in the case where Δ is false and 0 is true, the conjunction is true. Therefore, the conjunction is not a contradiction so the argument form is invalid.

Another such formal fallacy is called the fallacy of conjunction, and involves an error of the following form:

2.3

1. $\sim (\Delta \ . \ 0)$
2. $\sim \Delta$

$\therefore$ 3. ~ 0

1. It is not the case that both the Secret Service and the CIA conspired to kill JFK.
2. It is not the case that the Secret Service conspired to kill JFK.

$\therefore$ 3. It is not the case that the CIA conspired to kill JFK.

Again, from our study of logic, we may prove that 2.3 is invalid by using the truth table method:

Δ	0	$[(\sim (\Delta \ . \ 0) \ . \sim \Delta) \ . \sim \sim 0]$
t	t	f . f . t = f
f	t	t . t . t = t
t	f	t . f . f = f
f	f	t . t . f = f

Again, in the case where Δ is false and 0 is true, the conjunction is true. Therefore, the conjunction is not a contradiction, so the argument form is invalid.

We can see then, that any formal fallacy can be exposed by capturing the logical form of the statement composing the argument containing the formal fallacy. We may then simply apply PC or LPC rules to point out the error in reasoning involved which allows us to show that such fallacious arguments offer no reason to persuade one to accept their conclusions since we have shown that the argument employing the fallacy fails to support the conclusion.

Models

1. This provides an opportunity to present invalid arguments or valid arguments that are unsound for evaluation. Point out that valid but unsound arguments do not commit formal fallacies, since they do not involve errors in formal reasoning.

2. Consider the invalid arguments you have previously presented from Gardner. This is a good opportunity briefly to discuss the psychology of persuasion. Point out and underscore that our interest in persuasion is to be persuaded by arguments which successfully support their conclusions, and not to be persuaded by arguments which fail to support their conclusions.

3. This is also a good opportunity to relate our consideration of arguments to a consideration of reasonable beliefs. Consider Ullian's and Quine's discussions in The Web of Belief.

Exercises

1. Have the students bring in examples of formal fallacies from the reading, or from advertising. Have them evaluate them as a group.

2. Have the students write a short paper in which they are asked to persuade a wealthy individual to fund a particular project by any means they desire. Have them exchange papers and evaluate the arguments.

Subsection 3 - Fallacies of Ambiguity

Besides formal logical errors in reasoning resulting from violations of PC or LPC rules, there are also what we shall call informal errors in reasoning that, when exposed, also allow us to show that arguments containing them fail rationally to support their conclusions.

Some philosophers, however, have argued that there are no informal fallacies; what have been called informal fallacies are not errors in reasoning, but simply enthymemes. Consider the following example.

E.

1. Event A precedes event B in time

:. 2. Event A causes event B.

Such philosophers claim that E does not involve an error in reasoning, since E is already an enthymeme.

E.1

1. Event A precedes event B in time.
2. If event A precedes event B in time, then event A causes event B.

:. 3. Event A causes event B.

E.1 is a valid deductive argument. Where, they ask, is the informal fallacy?

We know from our study of deductive logic that any argument such as E can be made deductively valid by supplying a conditional with the conjunction of the premises as antecedent and the conclusion as consequent. However, this just leads us to find an error in reasoning involved in formulating such a conditional. For example, we may account for the unsoundness of E.1 by arguing that 2 is false. It is false because to reason that if event A precedes event B in time, then event A causes event B is to commit a specific error in reasoning which we shall call the false cause fallacy.

Such errors are not formal errors in reasoning, but usually involve providing evidence of some kind which fails to support the truth of a particular conclusion. This evidence, while failing to support the truth of a particular conclusion, may be psychologically persuasive. Therefore, it seems that there are informal fallacies, and we ought to consider them.

One group of such informal errors in reasoning are called fallacies of ambiguity. Fallacies of ambiguity involve errors in reasoning resulting from ignoring the ambiguities of ordinary language like ambiguous words, phrases, or sentences. From our consideration of clarifying arguments, we may now clearly recognize the specific fallacies of ambiguity, which include equivocation, amphiboly, accent, composition, and division. We shall now briefly consider each fallacy of ambiguity.

Equivocation. We have already considered the equivocal use of terms in our discussion of clarifying arguments in Section Three, Subsection 3. As we have seen, the equivocal use of a term involves confusing different intensions or extensions of the same term. In many arguments, relative terms like (non-moral) 'good', 'small', 'between', etc. lend themselves to equivocal uses. Consider the following example:

3.1

1. Mike is a small man.
2. A small man is a small animal.

∴ 3. Mike is an small animal.

Like in Section Three, Subsection 3, 3.1, this argument 3.1 involves the equivocal use of a term. However, here the relative term 'small' is used equivocally in premise 2. Of course, we know that in relation to other men, Mike may be small, however, in relation to mice, for example, Mike may not be small at all. 'Small' is, therefore, used equivocally since it is used to relate two different things; Mike to other men and Mike to all animals. 'Small' is equivocal not because it has different intensions, but because a sentence like 2 or 3 of 3.1 can express different propositons depending on what the extension of 'small' is taken to be.

Amphiboly. The fallacy of ambiguity known as amphiboly involves the ambiguity of grammatical constructions rather than the ambiguity of terms. The fallacy of amphiboly is committed when a conclusion is invalidly inferred from a premise because of the premises' ambiguous grammatical structure. Consider the following argument:

3.2

1. The teacher assigned term papers.
2. The teacher asked the students to think about a topic for the term papers.
3. The teacher said "leave a note saying what you will do with me."

∴ 4. The teacher requested a note describing physical assaults on her person.

The fallacy of amphiboly is committed in this case, given the teacher's admittedly ambiguous statement, when one infers that the teacher was requesting a note describing physical assaults on his or her person, such as "I am going to twist your arm off." This is a fallacy because the conclusion inferred is not supported by the context in which the gramatically ambiguous statement occurs. The statement does not provide evidence to support the conclusion. Obviously, the principle of charity requires one to translate the ambiguous statement as "Leave me a note in which you state the topic you have chosen for your term paper."

Accent. The fallacy of ambiguity known as accent also involves the ambiguity of gramatical constructions. The fallacy of accent is committed when a conclusion is invalidly inferred from a premise because of placing unwarranted emphasis on certain words in a premise cited as evidence for a conclusion. Consider the following argument:

3.3

1. The Biju Theater sells popcorn, candy, and soft drinks.
2. There is a cigarette machine in the lobby of the Biju.
3. There is a sign on the door which reads "smoking is permitted in the last four rows."

∴ 4. One may only smoke in the last four rows, one may not eat popcorn, candy, or drink soft drinks.

The fallacy of accent is also commmitted in this case, given the sign in the theater if one puts equal emphasis on all words and cites the sign as evidence to support the conclusion that it is a simple fact that one may smoke in the last four rows, although one may also smoke in any other row. It is also committed if one puts emphasis on 'permitted' and cites the sign as evidence that the theater management disapproves of smoking but allows for it in the last four rows. These are fallacies of accent because the conclusions inferred by putting emphasis on different words or groups or words are not supported by the context in which the grammatically ambiguous statement occurrs.

Compositon and Division. The fallacies of ambiguity known as composition and division both involve inattention to language attributing properties to a part or to a member in a class, and properties to a whole or to class. The fallacy of composition is committed when one argues that if the parts of a complex object or the members of a class have a property, then the complex object or the class has this property. Consider the following argument:

3.4

1. I can lift a piston for a Cadillac.
2. I can lift a door for a Cadillac.
3. I can lift the wheels for a Cadillac.
4. I can lift the crank shaft for a Cadillac.
5. I can lift the transmission case for a Cadillac.
6. I can lift the block casting for a Cadillac.
7. I can lift the front seat of a Cadillac (and so on for each individual part)

∴ 8. I can lift a Cadillac.

This is an example of the fallacy of composition because the fact that I can lift each individual part of a Cadillac does not provide evidence that I can lift the car. Obviously, when the car parts are assembled, their cumulative weight will be too much for me to lift. Thus, from the fact that the individual parts of a complex object like a Cadillac each have a property, it does not follow from this that the complex object as a whole has the property.

Similarly, the fallacy of division is committed when one argues that if a complex object or class has a property, then the parts of the complex object or the members of the class have this property. Consider the following argument:

3.5

1. No one can lift a Cadillac.
2. No one can lift a Chrysler Imperial.
3. No one can lift a Lincoln Continental.
4. A Cadillac, a Chrysler Imperial and a Lincoln Continental all have steering wheels the same size and shape.

:. 5. No one can lift the steering wheel of a Cadillac, or a Chrysler Imperial, or a Lincoln Continental.

This is an example of the fallacy of division because the fact that no one can lift any one of these cars does not support the conclusion that no one can lift the steering wheel from any one of these cars. Thus, from the fact that the complex object as a whole has the property, it does not follow that the individual parts of a complex object, like a car, each have the property.

Such fallacies of ambiguity involve errors in reasoning which fail to provide support for a given conclusion. In the absence of further argument and the reconstruction of such fallacious arguments, we are entitled to say that such arguments are simply no good.

Models

1. Present examples of each of these fallacies of ambiguity from situations in which one is required to interpret an ambiguous word or phrase. Point out how to recognize which interpretations are fallacious and which are not, and how to tell the difference.

2. Review the principle of charity as discussed in clarifying arguments and as applied to reconstructing arguments. Point out how applying the principle of charity often allows one to reconstruct an ambiguous statement and thereby to avoid drawing a conclusion from the statement fallaciously.

3. This is a good opportunity to discuss the notion of a class, and to distinguish it from the notion of a set as a more specialized kind of class.

Exercises

1. Have the students classify and explain various fallacies of ambiguity: (you can consult the logic texts for other examples).

   a) "Each person's happiness is a good to that person, and the general happiness, therefore, a good the aggregate of all persons." (J. S. Mill)

   b) Fords are expensive cars, so each part must be very expensive.

   c) Chevrolets are numerous. A 1920 Chevrolet is a Chevrolet. Therefore, 1920 Chevrolets are numerous.

d) A spark plug for a 1932 Dusenberg is only 50¢, so the car must be very inexpensive.

2. Have the students draw as many fallacious inferences as they can from the following. Have them explain why the they are fallacious, and then have them provide a clarification of the ambiguous statemement:

a) In the context of a TV news program: "Good evening. I am Mike Wallace for Sixty Minutes."

b) In the context of an advertisement for a particular brand of soft-drink: "Every serving that you pour costs a nickel not a penny more."

Subsection 4 - Fallacies of Relevance

While in all the fallacies we have considered so far, an argument involving an error in reasoning fails rationally to support the conclusion, there is a group of fallacies in which this failure is particularly obvious. What we shall call fallacies of relevance involve errors in reasoning resulting from no rational connection between premises and conclusions such that the evidence stated in the premises is totally irrelevant to the truth or probability of the conclusion. Particularly common specific fallacies of relevance that have been given names are _ad baculum_, _ad misericordiam_, _ad hominum_, _ad vercundiam_, _ad populum_, _ad ignorantium_, false cause, ignoring the question, complex question and begging the question. It is useful to note that these are the common ones which have been given names but this, by no means, exhausts such errors in reasoning. With this in mind, we shall now briefly consider each of these common fallacies of relevance.

Ad Baculum. *Ad baculum* is a Latin phrase which literally means "to the stick." Consequently, this fallacy is often referred to as the appeal to force. The *ad baculum* fallacy involves the most blatant examples of offering reasons that do nothing to support the truth or probability of a conclusion. The *ad baculum* fallacy involves offering threats as premises, perhaps intended to coerce one to accept the conclusion, but which fail to offer support for the truth of the conclusion. Consider the following argument:

4.1

1. Mr. Big likes his friends to be generous.
2. Mr. Big takes care of his generous friends by letting them live.
3. Mr. Big kills friends who are not generous.
4. You want Mr. Big to like you.

∴ 5. It is financially sound to sell Mr. Big your Polaroid stock at $.50 per share.

The *ad baculum* fallacy is committed in this case since premises 2, 3 and 4 contain threats which do not support the financial wisdom of selling your Polaroid stock at $.50 per share. This is a fallacy because it is not relevant to the issue at hand; the premises have no rational connection with and offer no rational support for the truth of the conclusion. The connection is merely a psychological one, which although practically important to consider, fails rationally to support the conclusion. Since our interest here is limited to rational support for given conclusions by arguments, we can simply refer such threatening situations as the above, or threats of force or physical violence to practical moral problem solvers.

Ad misericordiam. _Ad misericordiam_ is a Latin phrase which literally means "toward mercy or pity." Consequently, this fallacy is often referred to as the appeal to pity. The _ad misericordiam_ fallacy involves offering claims that harmful consequences or unhappiness for others will result, as premises, to support the truth of a given conclusion. Consider the following argument:

4.2

1. My father worked overtime to earn money to send me to college.
2. My mother took in wash to earn money to sent me to college.
3. My parents' only chance for happiness is that I get good grades in college.

∴ 4. I deserve an 'A' in Physics.

The _ad misericordiam_ fallacy is committed in this case since the chance of parental unhappiness is cited as support for the conclusion. This is a fallacy because such a harmful consequence is not relevant to the awarding of grades; making one's parents unhappy has no rational connection to the awarding of grades in the grading system. Therefore, such a claim offers no rational support for the truth of the conclusion.

Ad hominum. Ad hominum is a Latin phrase which literally means "to the human." Consequently, this fallacy is often referred to as the personal attack. The ad hominum fallacy involves offering claims about some person as premises in an argument against a conclusion that he supports. The ad hominum fallacy has two forms; first the abusive form, and secondly, the circumstantial form.

The abusive form of the ad hominum fallacy involves attacking the claim that a person makes by directly attacking the person. Consider the following argument:

4.3

1. Lars claims that abortion is wrong.
2. Lars is a stupid Norwegian.
3. Lar's mother's brother is Lars' father.
4. Lars is so ugly that Trolls drop dead when they see him.

:. 5. It is not the case that abortion is wrong.

The abusive form of the <u>ad hominum</u> fallacy is committed in this case, since the man making the claim is personally attacked without any specific critical evaluation of the man's claim. This is a fallacy because such a personal attack is not relevant to the truth or falsity of his claim; even stupid Norwegians can utter true propositions. Therefore, in the absence of more specific criticism of the claim itself, the statement that the man making the claim is a stupid Norwegian offers no rational support for the conclusion that his claim is not true.

The circumstantial form of the <u>ad hominum</u> fallacy involves offering as premises reasons why, by virtue of certain personal circumstances, one should accept or reject a particular conclusion. Consider the following argument:

4.4

1. Shawn claims that abortion is wrong.
2. Shawn is a devout Irish Catholic.

∴ 3. It is not the case that abortion is wrong.

The circumstantial form of the <u>ad hominum</u> fallacy is committed in this case since that Shawn is a devout Irish Catholic is offered as evidence to support the denial of his claim that abortion is wrong. In this form, an appeal

appeal is made to the personal circumstances of the man making the claim and this is cited as evidence to support the truth of the conclusion. This is a fallacy again because the man's personal circumstances are not relevant to the truth or falsity of his claim. The fact that he is a devout Catholic and that the Catholic Church is officially against abortion does not imply that abortion is wrong, nor does it imply that abortion is not wrong. Therefore, in the absence of more specific criticism of the claim itself, the fact that the man making the claim is a Catholic offers no rational support for the truth of the conclusion that his claim is false.

Ad vercundiam. Ad vercundiam is a Latin phrase which literally means "toward diffidence, or lack of trust." Consequently, this fallacy is often referred to as the illegitimate appeal to authority. The ad vercundiam fallacy involves appeal to an unsuitable authority as premises to support a given conclusion. It is useful to note that not all the appeals to authority are fallacious. For example, appeals to the claims of an expert forensic pathologist about a murder victim's cause of death count as evidence for a conclusion as to the cause of death since the expert is making claims in his field of expertise. On the other hand, the ad vercundiam fallacy involves an appeal to a given authority in a field to support a claim about something in an unrelated field. Consider the following argument:

4.5

1. The retired English Teachers Association of New York passed the statement that nuclear power plants are safe.
2. The senior class at West High School passed the statement that nuclear power plants are safe.
3. AFL-CIO Local 404 of the United Garbage Collectors voted to pass the statement that nuclear power plants are safe.

∴ 4. Nuclear power plants are technologiclaly and environmentally safe.

The <u>ad vercundiam</u> fallacy is committed in this case since the authorities appealed to in support of the claim that nuclear power plants are safe are not authorities on nuclear power. This is a fallacy because these claims about the safety of nuclear power plants are irrelevant to determining that they are safe. The claims have no rational connection to the resolution of the question. Therefore, such claims offer no rational support for the conclusion that nuclear power plants are safe.

<u>Ad populum</u>. <u>Ad populum</u> is a Latin phrase which literally means "to the people." Consequently, this fallacy is often referred to as the popular, or the band wagon fallacy. The <u>ad populum</u> fallacy involves an appeal to generally

accepted beliefs or majority opinion as premises to support a given conclusion that is not about generally accepted beliefs or majority opinion. In this sense, then, the ad populum fallacy involves an appeal to majority opinion as an authority to be used as evidence for or against a particular claim. Consider the following argument:

4.6

1. 51% of the people interviewed in the U.S. believe that UFO's are flown by intelligent visitors from outerspace.
2. 60% of the people interviewed in England believe this.
3. 90% of the people interviewed world-wide believe this.

∴ 4. There are intelligent life forms able to contact our Earth from outerspace.

The ad populum fallacy is committed in this case since majority opinion is cited as evidence to support the claim that there are intelligent life forms able to contact Earth. This is a fallacy because such majority opinion is not relevant to the claim at issue; that intelligent visitors from outerspace are believed in by a majority of those individuals interviewed has no rational connection to the claim that there are intelligent life forms in outerspace able to contact our Earth. Many children believe in Santa Clause, yet that is hardly taken as serious evidence to support a serious claim that

Santa Clause exists. Therefore, such an appeal offers no rational support for the truth of the claim that there are intelligent life forms in outerspace able to contact our Earth.

Ad ignorantiam. Ad ignorantiam is a Latin phrase which literally means "toward ignorance." Consequently, this fallacy is often referred to as the appeal to ignorance. The ad ignorantiam fallacy involves offering appeals to ignorance as premises to support a given conclusion. This involves arguing that a certain conclusion is true or highly probable because either it has not been disproven (i.e., we do not know that it is false) or one does not know how it could be disproven. Consider the following argument:

4.7

1. The Air Force has explained various UFO sitings as natural phenomena
2. Scientists have explained various UFO sitings as natural phenomena.
3. Neither the Air Force, nor scientists, nor anyone else have proven that extraterrestrial flying saucers do not exist.

∴ 4. Extraterrestrial flying saucers do exist.

The ad ignorantiam fallacy is committed in this case since the evidence appealed to in support of the claim that extraterrestrial flying saucers exist is the fact that no one has been able to prove that they do not exist. This is a fallacy because the fact that no one has been able to disprove that extraterrestrial flying saucers exist is irrelevant as support for the claim that they do exist. While we may show that all phenomena claimed to be evidence for their existence are natural terrestrial phenomena, and that, therefore, there is no evidence to support the claim that they do exist, the claim that no one has been able to disprove that they exist has no rational connection to the resolution of the question. Note that this is not the same claim as that no one has been able successfully to refute evidence claimed to support that they exist, which is false. Therefore, such a claim offers no rational support for the conclusion that extraterrestrial flying saucers exist.

False cause. The false cause fallacy involves an appeal to premises stating simply that event A came before result C in time to support the conclusion that A caused C. While many causes do, in fact, precede the result in time, it is not simply the fact that the cause precedes the result in time that determines the cause. Consider the following argument:

4.8

1. Every morning Sidney puts on brown socks while dressing, and drives safely to work.
2. Sidney does everything the same way every day.
3. Today, Sidney put on blue socks for the first time while dressing and had an auto accident on the way to work.

:. 4. Sidney's putting on blue socks caused him to have an auto accident.

The false cause fallacy is committed in this case since the fact that Sidney's putting on blue socks precedes the accident in time is used to support the conclusion that Sidney's putting on blue socks caused the accident. This is a fallacy because the fact that putting on blue socks precedes the accident in time is not relevant to the determination of the cause of the accident. An infinite number of events precede the accident in time. For example, the sacking of Rome, the invasion of Normandy, and the resignation of Richard Nixon as President, yet none of these can be said to cause the accident simply because they precede the accident in time. Therefore, such a claim offers no rational support for the conclusion that putting on blue socks caused the accident.

Ignoring the question. The fallacy of ignoring the question involves offering an argument in support of some conclusion that is totally irrelevant to the question at hand.

Consider the following argument:

4.9

1. Murdering an innocent person violates the laws of God and the laws of men.
2. All violations of the laws of God and the laws of men deserve strict punishment.

∴ 3. Peter is guilty of murdering his mother.

The fallacy of ignoring the question is committed in this case since the argument presented supports a conclusion that is totally irrelevant to the actual guilt or innocence of the defendant. This is obviously a fallacy. The truth or falsity of the conclusion actually supported by the premises provides no rational support for the conclusion in question.

Complex question. The fallacy of complex question involves supposing that a simple yes or no answer, or another simple short answer to a question containing another hidden question is appropriate to support a particular conclusion. Thus, in answering a complex question, one is required to presuppose an answer to the hidden question that one may not wish to presuppose. Thus, one may ask such complex questions in order to trick someone into giving an answer that implies support for a particular conclusion that is not supported by other evidence. Consider the following argument:

4.10

1. The principal asked Joe if he still hated school.
2. Joe answered "no."
3. Joe flunked chemistry six months ago.
4. Since Joe does not still hate school, he must have hated it six months ago.

∴ 5. Joe flunked chemistry because he hated school.

The fallacy of complex question is committed in this case since both "yes" and "no" answers to this question imply that the student did at some time hate school, and this may not be the case at all. Thus, the question is really two questions. First, "Did you ever hate school?", and second, "If you ever did hate school, do you still hate it now?" This is a fallacy since if the student answers no, the principal may fallaciously conclude that the student at one time did hate school. Yet a "no" answer to this complex question is not good evidence for the claim that the student once hated school. Therefore, answers to such complex questions do not offer rational support for conclusions concerning the hidden question.

<u>Begging the question</u>. The fallacy of begging the question involves assuming as a premise the conclusion to be proved by the argument. This fallacy is sometimes called circularity, or arguing in a circle. Often in arguments which involve the fallacy of begging the question, the premise often simply says in different words what the

conclusion affirms. Consider the following argument:

4.11

1. The unrestrained expression of one's opinions is for the public welfare.

∴ 2. Freedom of speech is good.

The fallacy of begging the question is committed in this case since the conclusion simply says in other words what the premise affirms. This is a fallacy because there is no support offered for the conclusion at all since we must assume that the conclusion is true to prove that the conclusion is true. Therefore, such a claim offers no rational support for the claim that freedom of speech is good.

We have seen that each of these formal and informal fallacies involve errors in reasoning which result in a failure rationally to support a conclusion. Upon recognizing such errors, we are, therefore, entitled to claim that arguments employing them are no good.

Models

1. Present examples of each of these fallacies of relevance. Consider Blum's book as a source for many fallacies of relevance.

2. Point out that while all fallacious arguments fail to support their conclusions, that is, that the premises are in some sense irrelevant to the conclusion, fallacies may be more precisely classified by

considering the exact nature of this irrelevance. Review the formal fallacies, and the fallacies of ambiguity by providing examples of these fallacies and by providing examples of fallacies of relevance.

3. Review the nature of psychological persuasion. Consider obvious examples such as torture. In more advance sections, you might raise the question as to whether this may be said to involve rational persuasion. Have the students offer explications of 'rational persuasion'. Consider ethical and aesthetic arguments, and raise the question "Do such arguments involve rational persuasion?" Point out that this is a philosophical problem which many philosophers have prolifically addressed.

Exercises

1. Have the students classify and explain various fallacies of relevance: (You can consult the logic texts for other examples)

    a. There is intelligent life on other planets because John Young, a former astronaut, believes that there is.

    b. Charlie Hixon and Calvin Parker are good old country boys so their story of being studied by extra-terrestrial spacemen must be true.

    c. I deserve to be paid more for my work because the cost of living has gone up, my wife is sick, and I can't make my car payments.

    d. More cigarettes have been smoked in America than anywhere else for years and during these years, America has become the strongest nation in the world, so help strengthen America: smoke cigarettes.

    e. He is a rich man so we need not listen to his arguments opposing welfare.

    f. I will not contribute to the college alumni fund unless my kid is passing Chemistry.

    g. Most people believe in God, so God exists.

    h. No one has been able to prove that reincarnation does not occur, so reincarnation does occur.

i. The defendant is accused of running a red light. A stop light is not necessary at that intersection.

j. When did you stop beating your dog?

k. One ought not to commit fallacies because one ought not to commit psychologically persuasive errors in reasoning.

2. Have the students write a paper in which they discuss practical consequences of ignoring fallacies in arguments and adopting conclusions for which there is no rational support. Have them consider, for example, politics, education, and business.

Section Five

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